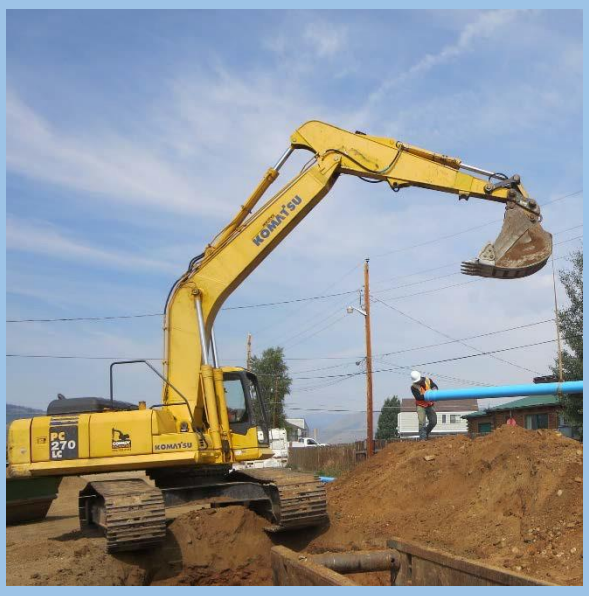
Drinking Water Infrastructure Needs Survey and Assessment

Sixth Report to Congress



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Drinking Water Infrastructure Needs Survey and Assessment

Sixth Report to Congress

U.S. Environmental Protection Agency
Office of Water
Office of Ground Water and Drinking Water
Drinking Water Protection Division
Washington, D.C. 20460

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Acknowledgments

Many dedicated individuals contributed to the 2015 Drinking Water Infrastructure Needs Survey and Assessment. We would like to thank the states for their active participation and continuing interest in the project. And most importantly, we would like to thank the operators and managers of the thousands of water systems who spent their valuable time providing information for the Assessment.

Executive Summary

Total National Need

The U.S. Environmental Protection Agency's (EPA's) sixth national assessment of public water system infrastructure needs shows a total 20-year capital improvement need of $472.6 billion. This estimate represents Drinking Water State Revolving Fund (DWSRF) - eligible infrastructure projects necessary from January 1, 2015, through December 31, 2034, for water systems to continue to provide safe drinking water to the public. The national total comprises the infrastructure investment needs of the nation's approximately 49,250 community water systems (CWSs),[1] 21,400 not-for-profit noncommunity water systems (NPNCWSs), American Indian water systems and Alaska Native Village water systems.[2] The findings are based on the 2015 Drinking Water Infrastructure Needs Survey and Assessment (DWINSA or Assessment), which relied primarily on a statistical survey of public water systems. The survey response rate was 99.7 percent (2,592 responses from 2,600 systems surveyed), the highest response rate in the history of the Assessment, providing a high degree of confidence in the statistical precision of the Assessment's findings.

$472.6 Billion is Needed

The nation's drinking water utilities need $472.6 billion in infrastructure investments over the next 20 years for thousands of miles of pipe as well as thousands of treatment plants, storage tanks, and other key assets to ensure the public health, security, and economic well-being of our cities, towns, and communities.

Authority, Purpose, and History

The 1996 Safe Drinking Water Act Amendments mandated that EPA conduct an assessment of the nation's public water systems' infrastructure needs every four years and use the findings to allocate DWSRF capitalization grants to states. The DWSRF was established to help public water systems obtain financing for improvements necessary to protect public health and comply with drinking water regulations. From 1997 to 2016, states provided $32.5 billion through DWSRF programs to water systems for 13,183 projects.

The estimate covers infrastructure needs that are eligible for (but not necessarily financed by) the DWSRF, including the installation of new drinking water infrastructure and the rehabilitation, expansion, or replacement of existing infrastructure. The results of the Assessment are used to allocate the DWSRF capitalization grants to the states for their DWSRF programs and to the EPA regional offices for American Indian and Alaska Native Village systems. The reported projects may be needed to address existing infrastructure that is deteriorated or undersized, ensure compliance with regulations, provide system resilience, improve energy efficiency, or improve cost effectiveness. Cost estimates reflect comprehensive construction costs including engineering and design, purchase of raw materials and equipment, construction and installation labor, and final inspection.

[1] The estimated 49,250 CWSs was derived from the December 2013 Safe Drinking Water Information System (SDWIS) freeze for active community water systems, excluding federally-owned systems.

[2] The inventory of American Indian and Alaska Native Village water systems was derived from the December 2009 SDWIS freeze.

EPA recognizes that there are significant water system needs that are generally ineligible for DWSRF funding, such as raw water dams and reservoirs, projects related primarily to population growth, and water system operation and maintenance costs. Because the Assessment is directly associated with the allocation of DWSRF capitalization grants to states and tribal set-aside funds to EPA regional offices, needs ineligible for DWSRF funding are not included in the estimate.

National Need Compared to Previous Needs Assessments

EPA conducted five previous Assessments in 1995, 1999, 2003, 2007, and 2011. Exhibit ES.1 presents the total national need for the Assessments, adjusted to 2015 dollars. The 67 percent increase in need between 1999 and 2003 was the result of a focus on better capturing the full 20-year need of surveyed systems by including an asset inventory-based approach to identify longer-term infrastructure replacement and rehabilitation needs. Beginning with the 2003 Assessment, a water system's inventory of existing infrastructure assets, along with a simple statement of need, would be considered as survey-generated documentation sufficient to justify certain replacement and rehabilitation needs (as described in Appendix C). The asset inventory-based approach continued in subsequent Assessments with data generally demonstrating increases in inventoried assets on a national basis. Total national need increased by about 1 percent in both the 2007 and 2011 Assessments, essentially the same statistical result as the 2003 findings. The 2015 Assessment, however, reveals a 10 percent increase in the estimate of total national need with survey data indicating the largest increase in rehabilitation and replacement needs for existing infrastructure, specifically in the water transmission and distribution project category. This increase was seen in both medium and large sized systems.

Fully Capturing Longer-Term Needs

The 2015 Assessment continued the practice used since the 2003 effort to better capture 20-year investment needs by including an asset inventory-based approach to identify long-term infrastructure replacement and rehabilitation needs.

For the 2015 Assessment, EPA adjusted its statistical methodology slightly to make use of a modified panel approach for medium-sized systems, in which EPA resurveyed a large portion of the systems that participated in the 2011 Assessment (as described in Appendix A). This approach facilitated the process of participation for the medium sized systems by allowing a majority of these systems to update their responses from the 2011 Assessment, which led to more complete inventories of needs in the 2015 Assessment than in prior previous Assessments.

Exhibit ES.1: DWINSA Comparison of 20-year National Need (in billions of January 2015 dollars)

Year	1995	1999	2003	2007	2011	2015
National Need	$253.6	$250.9	$419.4	$423.7	$428.6	$472.6

Individual State Need

As presented in Chapter 2, the 2015 Assessment shows significant changes in some states' needs from the previous Assessment. These changes will result in modifications to individual states' DWSRF allotments. Throughout the history of the DWINSA, each state's needs change from one survey to the next, sometimes significantly. Such changes in state need can be attributed to a number of factors, including expected changes in the status of projects (i.e., recently planned projects versus initiated or completed projects).

Regulatory Need

The findings of the 2015 Assessment indicate that the need associated directly with Safe Drinking Water Act (SDWA) regulatory compliance remains a relatively small percentage, just over 12 percent of the total national need. Most water system needs are not directly related to violations of, or compliance with, SDWA regulations. Most needs, such as the replacement or rehabilitation of leaking water mains, are ongoing investments that systems must make to continue delivering safe drinking water to their customers.

Data Presentation

Throughout this report, information presented in the tables and figures is derived from DWINSA survey data from the referenced year unless otherwise noted. Data for small systems (serving 3,300 or fewer people) is extrapolated from information collected in 2007; data for American Indian and Alaska Native Village systems is extrapolated from information collected in 2011; and data for Not-for-Profit Noncommunity water systems is extrapolated from information collected in 1999.

Small System Need

The 2015 Assessment includes a total national need of $74.4 billion for small systems. Small systems are defined as serving 3,300 or fewer people. For the 2015 Assessment, EPA did not directly survey small systems but estimated the infrastructure investment needs for these systems by adjusting the findings from the field survey completed for small systems in states, Puerto Rico, and the U.S. territories for the 2007 Assessment. In making the adjustment, EPA applied 2015 cost models using the current inventory of small systems.

Needs of American Indian and Alaska Native Village Water Systems

As presented in Chapter 3, the needs of water systems serving American Indians and Alaska Native Villages total $3.8 billion. For the 2015 Assessment, EPA did not directly survey these systems but estimated the infrastructure investment needs by adjusting the findings from the 2011 Assessment. In making the adjustment, EPA applied 2015 cost models using the 2011 inventory of systems. This need represents a small percentage of the nation's total drinking water infrastructure need. This need is, however, associated with higher average per-household costs due to unique challenges that many of these water systems face. These public water systems are almost all small and are often located in remote rural areas, some in areas with permafrost, and the communities served may have households that lack access to the public water supply. These conditions present special challenges for providing drinking water service.

"Beyond providing the basis for allotting the Drinking Water State Revolving Fund, the Assessment and Report to Congress have been instrumental in helping systems to more fully inventory their assets and to look out over a long-term planning horizon. The evolution in water system capital planning continues as systems increasingly adopt asset management strategies that will enable them to most cost-effectively ensure delivery of service that protects public health and supports economic prosperity." – Peter Grevatt, Director, EPA Office of Ground Water and Drinking Water.

Water Industry Capital Investment Planning and Documentation of Needs

Systems submitted a variety of planning documents and excerpts of documents in support of projects reported for the 2015 Assessment. These documents make clear that the water industry's approach to understanding assets and asset condition, as well as the industry's approach to capital investment planning, are evolving and yielding an increasingly robust understanding of long-term needs. In general, water utilities are developing increasingly complete inventories of their assets. Some systems are adopting asset management techniques to document the condition of assets and to plan for their rehabilitation or replacement. However, for many other systems, the information and documentation provided indicates that a significant gap still exists between their inventory of infrastructure and their knowledge of that infrastructure's condition or remaining useful life.

Chapter 1: Findings - National Need

2015 Total National Need

The 20-year national infrastructure need estimated by the 2015 Assessment is $472.6 billion. The breakout of the need by system size and type is presented in Exhibit 1.1.

Exhibit 1.1: Total National 20-year Need (in billions of January 2015 dollars)

System Size/Type	Need	Population Served (millions)***
Large Community Water Systems (serving over 100,000 people)*	$174.4	141.7
Medium Community Water Systems (serving 3,301 to 100,000 people)*	$210.6	139.4
Small Community Water Systems (serving 3,300 and fewer people)†	$74.4	23.4
Not-for-Profit Noncommunity Water Systems‡	$5.1	
Total State Need	**$464.6**	
American Indian Water Systems§	$3.1	1.04
Alaska Native Village Water Systems§	$0.7	0.08
Costs Associated with Proposed and Recently Promulgated Regulations**	$4.2	
Total National Need	**$472.6**	

Note: Numbers may not total due to rounding.

* "Large" and "Medium" community water systems are defined the same as for the 2007 and 2011 Assessments but are different than in the 2003 and previous Assessments. See Appendix A for more information.

† Based on 2007 Assessment findings adjusted to 2015 dollars, an updated inventory, and updated cost models.

‡ Based on 1999 Assessment findings adjusted to 2015 dollars. Population cannot be determined.

§ Based on 2011 Assessment findings adjusted to 2015 dollars and updated cost models.

** Needs associated with the Proposed Radon Rule taken from EPA economic analyses. Population cannot be determined.

*** Population for state, American Indian, and Alaska Native Village systems was derived on 12/8/2016 from EPA's SDWIS Federal Reports website: https://ofmpub.epa.gov/apex/sfdw/f?p=108:1:::NO:1. The information is for community water systems. These values do not include populations for systems defined as "Federal Systems," which are not eligible for DWSRF funding.

The Assessment addressed community water systems (CWSs) and noncommunity water systems (NCWSs) that serve not-for-profit entities (referred to as not-for-profit noncommunity systems or NPNCWS) because only

those entities are eligible for DWSRF funding.[3] The results for large and medium CWSs, regulated by the states, were derived from surveying all large systems in the United States (serving over 100,000 people) and a statistically representative sample of the nation's medium systems (serving between 3,300 and 100,000 people). The results for small CWSs (serving fewer than 3,300 people), regulated by the states, Puerto Rico and U.S. territories, were estimated from the Assessment conducted in 2007. The results for American Indian and Alaska Native Village CWSs (primarily in the small system category, with the remainder in the medium system category) were estimated from the Assessment conducted in 2011. The results for the NPNCWSs in states, Puerto Rico, and U.S. territories were adjusted to 2015 dollars from the 1999 Assessment findings.[4]

A community water system is a public water system that serves at least 15 connections used by year-round residents or that regularly serves at least 25 residents year-round. Cities, towns, and small communities as well as mobile home parks and home-owner associations may all own and operate a community water system.

A noncommunity water system is a public water system that is not a community water system and that serves a nonresidential population of at least 25 individuals daily for at least 60 days of the year. Schools and churches are examples of noncommunity water systems.

The need reported in the Assessment includes projects for expanding, replacing, or rehabilitating existing infrastructure. It also includes projects to construct new infrastructure in order to preserve the physical integrity of water systems, increase resiliency or efficiency, and to convey drinking water to existing residential, commercial, and industrial customers. Projects vary greatly in scale, complexity, and cost—from rehabilitating a small storage tank to replacing an entire treatment plant to constructing a high-capacity pipeline.

The results presented in this report will determine the allocation of DWSRF capitalization grants and factor into the allocation of the tribal set-aside funding to EPA regional offices for federal fiscal years 2018 through 2021. Projects that are ineligible for DWSRF funding, even though these necessary projects may constitute significant capital expenditures for local communities, are not included. The approach and methodologies for discerning needs are further detailed in Appendix A. A summary of the types of projects included in the Assessment, as well as specific types of unallowable projects, is presented in Appendix C. EPA recognizes that projects not eligible for DWSRF funding can be significant, if not critical, water system needs, but they are outside the scope of this Assessment. In addition, the Assessment does not seek to capture information on the financing alternatives being pursued or considered by systems for individual projects. The DWSRF is intended as a supplement to, not a replacement for, funding by states, localities and rate payers.

[3] The Assessment does not address federally-owned water systems as they are not eligible for DWSRF funding.

[4] The confidence in the estimated need of NPNCWS is lower than that of the community water systems because it is based on data from a small national sample of systems collected in 1999. However, the uncertainty this introduces is small because of the relatively small need associated with NPNCWSs.

Economic Benefits of Water Infrastructure Investment

The $472.6 billion represents the need associated with hundreds of thousands of miles of pipe, thousands of treatment plant and source water projects, and billions of gallons of storage (based on survey responses). Investments in water systems not only provide assurances of continued delivery of safe drinking water to American homes, schools, and places of business, they are key to local economies across the United States.

The Department of Commerce Bureau of Economic Analysis (BEA) estimates that for each additional dollar of revenue in the water and sewer industry, the increase in revenue that occurs in all industries is $2.62 in that year. Further, adding one job in water and sewer creates 3.68 jobs in the national economy to support that job. The estimate is based on a 2008 analysis done by the U.S. Conference of Mayors using BEA's Regional Input-Output Modeling System (RIMS II). [*]

[*]U.S. Conference of Mayors. "Local Government Investment in Municipal Water and Sewer Infrastructure: Adding Value to the National Economy" (August 14, 2008).

2015 Total National Need Compared to EPA's Previous Assessments

EPA conducted its previous Assessments in 1995, 1999, 2003, 2007 and 2011. Exhibit 1.2 presents the total national need for each Assessment. The first row shows the total need as reported in each Report to Congress, i.e., "current year dollars." These amounts are then adjusted for inflation ("cost adjustment factors" presented in the exhibit) to report the need in 2015 dollars in the "Total National Need in 2015 Dollars" row in the exhibit. This allows for a comparison in real dollars of the changes in needs as assessed by the survey efforts. EPA used the Construction Cost Index (CCI) compiled by McGraw Hill Construction to adjust for inflation because it includes adjustments for labor rates as well as the cost of materials.

Exhibit 1.2 also shows the percent change in the total national need between each assessment over the course of the six national assessments. The 1.1 percent decrease in total need between 1995 and 1999 reflects refinements in project acceptance criteria; particularly the exclusion of raw water dams and reservoirs from the Assessment findings. The need increased substantially between the 1999 and 2003 Assessments due, in part, to the addition in the 2003 Assessment of an asset inventory-based approach to better capture long-term replacement and rehabilitation needs for existing infrastructure (as described in Appendix B). Between the 2003 and 2007 Assessments and the 2007 and 2011 Assessments, the need increased only 1.0 and 1.2 percent, respectively. The 2015 findings, however, show a 10.3 percent ($44 billion) increase in need compared to the 2011 findings.

Exhibit 1.2: Total National 20-year Need Comparison to Previous DWINSA Findings (dollars in billions)

	1995	1999	2003	2007	2011	2015
Total National Need (as listed in Assessment Year's Report to Congress in Current Year Dollars)	$138.4	$150.9	$276.8	$334.8	$384.2	$472.6
Cost adjustment factor to January 2015 dollars (based on Construction Cost Index)	83%	66%	52%	27%	12%	--
Total National Need in 2015 Dollars*	**$253.6**	**$250.9**	**$419.4**	**$423.7**	**$428.6**	**$472.6**
Percent Change from Previous Assessment*	--	-1.1%	67.2%	1.0%	1.2%	10.3%

* Numbers may not total due to rounding.

Understanding the Increase in Need

The $44 billion increase in the total national need between the 2011 and 2015 Assessments is primarily due to changes in needs reported for large and medium systems in fully participating states, which increased $42.2 billion. (See Chapter 2 and Appendix A for more information about full- versus partial-participation states.) Combined, the changes in need for small systems, NPNCWSs, Alaska Native Village (ANV), and American Indian (AI) systems and medium systems in partial-participating states represent only $1.7 billion of the increase. As shown in Exhibit 1.3, between 2011 and 2015, the need reported for the rehabilitation, replacement and upgrade of existing infrastructure increased by $53.7 billion (an increase of 18 percent) while new infrastructure need for these systems actually declined by $11.4 billion, a decline of almost 30 percent. The dominant need to replace or rehabilitate water systems' existing infrastructure continues to increase relative to the needs for investing in new infrastructure and is the cause of the overall increase in total national needs in 2015.

Most of the increase in existing infrastructure need for large and medium systems between 2011 and 2015 is for replacement and rehabilitation of distribution and transmission pipe, which increased by $37.8 billion. Distribution and transmission needs account for most of the nation's needs, as described later in this section. On a percentage basis, existing distribution and transmission need increased more than other category types. Based on the information gathered during this Assessment, the increased needs are due to changes related to the survey methodology for 2015 that allowed states to build on their efforts from the previous survey and improve the estimate of their needs inventory.

Exhibit 1.3. Change in Need for New versus Existing Infrastructure between 2007, 2011 and 2015 Assessments*

	Total Need (billions of 2015 dollars)†			Change in Need (billions of 2015 dollars)†	
New vs. Existing Infrastructure	**2007**	**2011**	**2015**	**2007 to 2011**	**2011 to 2015**
New Infrastructure	$63.1	$38.6	$27.2	-$24.4(-38.8%)	-$11.4(-29.5%)
Rehabilitation/Replacement/Upgrade of Existing Infrastructure	$255.8	$291.4	$345.1	$35.7(+13.9%)	$53.7(+18.4%)
Net Increase	**$318.8**	**$330.1**	**$372.3**	**$11.2(3.5%)**	**$42.2(+12.8%)**

* Values are for large systems and medium systems in full-participation states. Excludes medium systems in partial-participation states, small systems, NPNCWS, AI and ANV systems.
† Totals may not total due to rounding.

Exhibit 1.4 addresses the net increase in need from the perspective of system size. Between 2011 and 2015, increase in replacement and rehabilitation needs was mostly attributed to medium systems ($33.0 billion out of $53.7 billion). Whereas between 2007 and 2011, the increase was mostly attributed to large systems ($26.7 billion out of $35.7 billion).

Exhibit 1.4. Change in Need by Medium versus Large Systems for Existing Infrastructure between 2007, 2011 and 2015 Assessments*

System Size	Change in Need (billions of 2015 dollars)†	
	2007-11	2011-15
Medium Systems	$8.9	$33.0
Large Systems	$26.7	$20.7
Net Increase	**$35.7**	**$53.7**

* Values are for large systems and medium systems in full-participation states. Excludes medium systems in partial-participation states, small systems, NPNCWS, AI and ANV systems.
† Totals may not total due to rounding.

Changes in Survey Approaches

Since the 2003 Assessment, EPA has worked with the states to improve estimates of long-term needs for infrastructure rehabilitation and replacement through enhanced accounting of water system assets. Some states have reported that they made this a primary effort for the 2015 Assessment. In addition, for the 2015 Assessment, EPA made use of a modified panel approach to resample a larger percentage of medium systems that participated in the 2011 Assessment (see Appendix A for more details on this approach). For these systems, project data from the 2011 Assessment were provided to water systems as a starting point for their 2015 survey response. By allowing water systems to update their responses from the 2011 Assessment, these systems were able to build on their efforts from the previous survey and improve the estimate of their existing assets. Some states also enhanced their support for systems that participated in the 2015 Assessment. State-wide approaches, combined with the improved systems' responses, may have contributed to the increase in specific states' need as well as the total national need.

Column installation of a new concrete water storage tank in Sleepy Hollow, NY.

State Approaches to Data Collection for the 2015 Assessment

"MassDEP increased its level of technical assistance to the surveyed systems for the 2015 survey. The expanded technical assistance helped the local systems more completely describe their infrastructure inventory and needs."

-Steve McCurdy, MassDEP

"In Colorado, we revised our approach in 2015 by focusing closely on existing inventory. We started with each system's actual database of pipe inventory, tanks, pump stations etc…. The panel approach was helpful because it allowed us to be more accurate and compare the different years of the survey. For instance, in 2015 we noticed two large systems with significant raw water pump station and pipeline networks that delivered water from the mountains to the treatment facilities. These were not included in 2011 survey because the systems did not realize that it should have been accounted for."

-Mark Henderson, CDPHE

"For the 2015 survey, North Carolina dedicated one full-time staff to the survey, with 25 regional engineers also contributing to the effort. NC arranged training for these staff with special emphasis on the preferred 'inventory-based' approach, which ensured that systems fully captured the needs associated with all existing infrastructure. In 2011, NC found that one water system with 9 million feet of pipe listed only 900,000 feet in the inventory. In another city, the 2011 DWINSA included only one pipe replacement project of 17,000 feet. In 2015, NC used an inventory-based approach to document that city's more complete pipe replacement needs of 37,000 feet. With a better understanding of the inventory-based approach and better QA/QC, the 2015 survey results better reflect the state's needs."

-Amanjit Paintal, NC DEQ

"In 2011, TDEC sent the surveys to the water system with instruction on filling out the forms. We found that there was some confusion and inconsistency in how the systems reported information. Due to the inconsistency in the previous report, in 2015, TDEC staff contacted the systems and worked with them over the phone to complete the surveys. We believe this lead to more accurate reporting."

-Anna Sartors, Tennessee DEC

Exhibit 1.5 provides a summary of needs across all Assessments since 1995 by system size and type. It also includes needs identified in this and past Assessments for regulations that are or were proposed or recently promulgated at the time of the assessment.

Exhibit 1.5: Total 20-Year Need by System Size/Type (and Regulation) for Each Assessment (in billions of January 2015 dollars)

System Type (and Regulation)	1995	1999	2003	2007	2011	2015
Large CWSs (serving more than 100,000 people)				$147.2	$161.9	$174.4
Medium CWSs (serving 3,301 to 100,000 people)				$183.6	$180.5	$210.6
Combined Medium/Large CWSs*	$183.0	$174.7	$342.3			
Small CWSs (serving 3,300 or fewer people)	$68.2	$51.8	$51.8	$75.2	$72.0	$74.4
Not-for-Profit Noncommunity Systems		$5.1	$5.1	$5.1	$5.1	$5.1
American Indian Water Systems	$2.4	$1.9	$1.9	$1.9	$3.0	$3.1
Alaska Native Village Water Systems		$1.8	$1.8	$1.8	$0.7	$0.7
Proposed and Recently Promulgated Regulations		$15.5	$16.5	$8.8	$5.5	$4.2
Total National Need	**$253.6**	**$250.9**	**$419.4**	**$423.7**	**$428.6**	**$472.6**

Note: Numbers may not total due to rounding.
*For 1995, 1999, and 2003 Assessments, medium and large CWS need is combined due to changes in the definitions of the system sizes.

Water distribution system improvement project in Williamsburg, CO.

EPA's Assessment continues to estimate a need within the range identified in other important reports. Below is a summary of the findings from other studies, all adjusted by EPA to January 2015 dollars.

- The 2002 Congressional Budget Office report "Future Investment in Drinking Water and Wastewater Infrastructure," estimates annual water system needs of $18.5 billion to $31.9 billion. This extrapolates to a 20-year need in the range of $369.5 to $637.8 billion.[5]

- The Water Infrastructure Network's "Clean and Safe Water for the 21st Century - A Renewed National Commitment to Water and Wastewater Infrastructure," estimates water system needs of $31.8 billion annually. This extrapolates to $636.4 billion over 20 years.[6]

- The 2012 American Water Works Association report "Buried No Longer: Confronting America's Water Infrastructure Challenge" estimated at least $1 trillion will be required over a 25-year period from 2010 through 2035 in order to restore existing water system pipe that has reached the end of its useful life and to expand pipe networks to meet growing populations. This estimate is significantly higher than the transmission and distribution total for EPA's 2015 Assessment, in part because it includes drinking water infrastructure investment needs related to population growth (which are not eligible needs under the DWSRF), and covers a longer period of time.[7]

Total National Need by Project Category

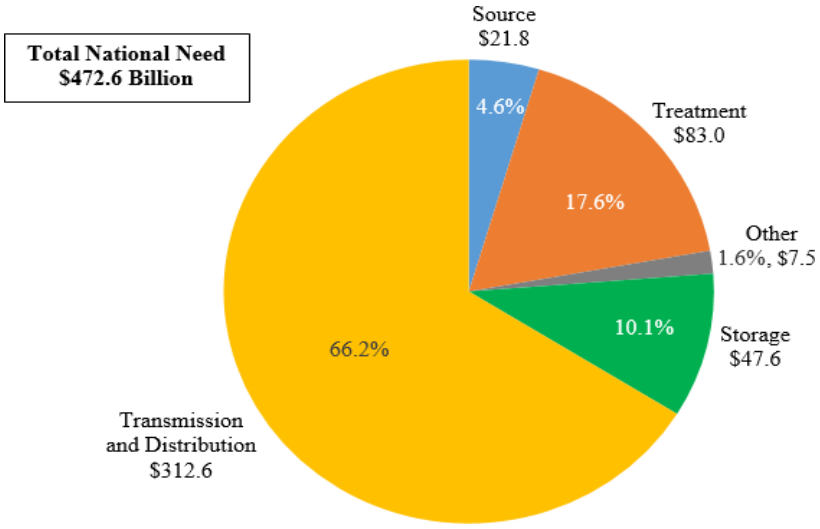
Infrastructure needs of water systems can be grouped into four major categories based on project type. These categories are drinking water source, transmission and distribution, treatment, and storage. Infrastructure in each category fulfills an important function in delivering safe drinking water to the public. Most needs were assigned to one of these categories. An additional "other" category is composed of projects that do not fit into one of the four, such as system-wide supervisory control and data acquisition (SCADA) or emergency generators. The treatment category includes most of the need that is associated with drinking water regulations. Exhibit 1.6 shows the total national need by project category. Exhibit 1.7 shows the total national need by water system size and type, as well as by project category.

[5] Congressional Budget Office, "*Future Investment in Drinking Water and Wastewater Infrastructure"* (November, 2002), p. ix. Needs were reported in 2001 dollars and have been adjusted to January 2015 dollars for comparison purposes.

[6] Water Infrastructure Network, *"Clean and Safe Water for the 21st Century - A Renewed National Commitment to Water and Wastewater Infrastructure"* (undated), p. 3-1. Needs were assumed to be in 1999 dollars based on the planning period and data used. Needs have been adjusted to January 2015 dollars for comparison purposes.

[7] American Water Works Association "*Buried No Longer: Confronting America's Water Infrastructure Challenge"* (February 2012), p. 9. http://www.awwa.org/Portals/0/files/legreg/documents/BuriedNoLonger.pdf (Needs were reported in 2010 dollars and have been adjusted to January 2015 dollars for comparison).

Exhibit 1.6: Total 20-year Need by Project Category (in billions of January 2015 dollars)



Note: Numbers may not total due to rounding.

Exhibit 1.7: Total 20-Year Need by System Size/Type and Project Category (in billions of January 2015 dollars)

System Size/Type	Distribution and Transmission	Treatment	Storage	Source	Other	Total Need
Large Community Water Systems (serving over 100,000 people)*	$120.1	$32.5	$13.4	$6.1	$2.3	$174.4
Medium Community Water Systems (serving 3,301 to 100,000 people)*	$144.9	$33.7	$20.0	$7.8	$4.3	$210.6
Small Community Water Systems (serving 3,300 and fewer people)†	$44.6	$11.0	$11.3	$6.7	$0.9	$74.4
Not-for-Profit Noncommunity Water Systems‡	$0.6	$1.0	$2.5	$1.0	$0.0	$5.1
Total States and U.S. Territories Need	**$310.2**	**$78.2**	**$47.1**	**$21.6**	**$7.4**	**$464.6**
American Indian and Alaska Native Village Systems§	$2.4	$0.6	$0.5	$0.2	$0.1	$3.8
Costs Associated with Proposed and Recently Promulgated Regulations**		$4.2				$4.2
Total National Need	**$312.6**	**$83.0**	**$47.6**	**$21.8**	**$7.5**	**$472.6**

Note: Numbers may not total due to rounding.

* "Large" and "Medium" community water system population ranges were the same for the 2007, 2011, and 2015 Assessments but differed in the 2003 and previous Assessments. See Appendix A for more information.

† Based on 2007 Assessment findings adjusted to 2015 dollars, an updated inventory, and updated cost models.

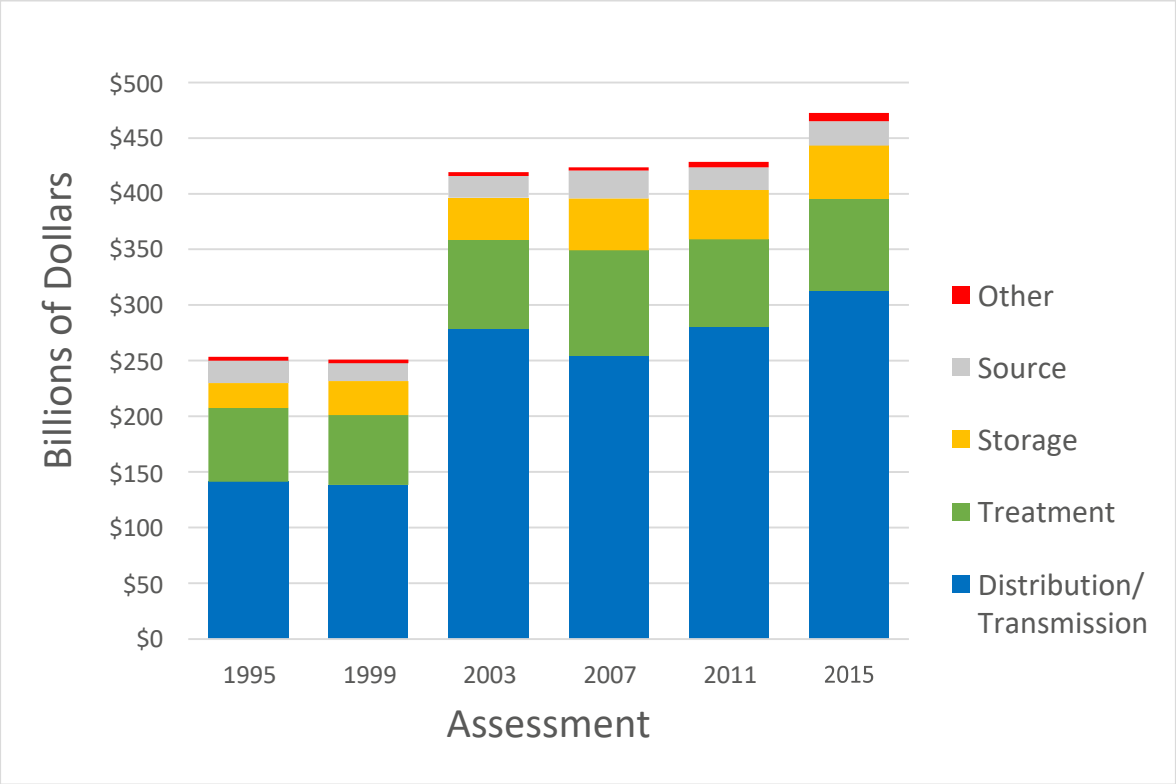
‡ Based on 1999 Assessment findings adjusted to 2015 dollars.

§ Based on 2011 Assessment findings adjusted to 2015 dollars and updated cost models.

** Needs associated with the Proposed Radon Rule - taken from EPA economic analyses.

Exhibit 1.8 shows the changes in need by project category over the last two decades across all six Assessments from 1995 to 2015.

Exhibit 1.8: Total 20-Year Need by Project Category for Each Assessment (in billions of January 2015 dollars)



Transmission and Distribution Needs

Transmission and distribution projects are the largest project category, totaling $312.6 billion over the next 20 years (66 percent of the total need in 2015). This category includes projects for rehabilitation and replacement of existing water mains, installing new pipe to eliminate dead end mains and the resulting stagnant water, installing new mains in areas where existing homes do not have a safe and adequate water supply, and installing or rehabilitating pumping stations to maintain adequate pressure. It also includes projects to address the replacement of appurtenances, such as meters to record flow and water consumption, backflow-prevention devices to avoid contamination, and valves that are essential for controlling flows and isolating problem areas during repairs.

Although the least visible component of a public water system, the buried pipes of a transmission and distribution network generally account for most of a system's capital value. Even small rural systems may have several hundred miles of pipe to reach all customers. In larger cities, replacement or rehabilitation of even small segments of the extensive underground networks of water pipes can be costly, approaching hundreds or thousands of dollars per foot (based on survey responses). The costs to a city include cost of construction as well as the costs related to disruption to the city's commerce. Regardless of water system size, projects addressing water mains and related

infrastructure present challenges. Pipe projects are typically driven by a utility's need to maintain drinking water quality and pressure as it travels through the distribution system from the treatment plant to the tap.

A substantial portion of the transmission and distribution need is for replacing or refurbishing aging or deteriorating transmission and distribution mains. These projects are critical to the delivery of safe drinking water and can help ensure compliance with many regulatory requirements. Failures in transmission and distribution mains can interrupt the delivery of water and introduce dangerous contaminants into the drinking water supply. The rate at which water mains require replacement or rehabilitation varies greatly by pipe material, age, soil characteristics, weather conditions, and construction methods. Systems that have not been able to implement or prioritize adequate programs to rehabilitate or replace mains may have proportionally more aged infrastructure, and therefore a higher level of need.

Total Length of Water Mains in the United States

A water system's inventory of pipe is typically one of its largest and most important assets. It is mostly buried, hidden from direct condition assessment, and expensive to replace. Estimates of how long pipes will last are critical to assessments of a system's infrastructure investment needs.

EPA estimates that community water systems currently have a total of 2.2 million miles of transmission lines and distribution mains. This estimate is based on data provided for medium and large systems in the 2015 Assessment and data provided for small systems in the 2007 combined DWINSA and Community Water System Survey. Note that this is the total amount of pipe, not the amount in need of replacement. EPA is able to report this information for the first time because a high percentage of respondents for the 2015 Assessment (98 percent) provided EPA with a total amount of pipe in their system.

Exhibit 1.9 shows pipe length in miles by system type and population category as well as the average length of pipe per system by size category. Large systems, defined as those serving over 100,000 people, have approximately 607,400 miles of pipe and average 943 miles per system (based on a census of large systems). Medium-sized systems, those serving between 3,301 and 100,000 people, have approximately 1,234,300 miles of pipe and 134 miles per system (based on a statistical sample of systems at the state level). Small systems, those serving fewer than 3,301 people, have approximately 379,600 miles of pipe and average 9.5 miles per system (based on a national sample).

American Indian systems have an approximate total of 9,930 miles of pipe and average 13.5 miles per system. This relatively high amount compared to small systems regulated by the states may be due to the rural nature of many Native American communities. Alaska Native Village systems have an approximate total of 480 miles with just 2.9 miles per system. This low value is because many Alaska Native Villages do not have piped water due to permafrost conditions. American Indian and Alaska Native estimates are based on a statistical sample of systems.

Exhibit 1.9. Total Length of Pipe for CWSs in the Nation by System Size (Year 2015)

System Type	Population Category	Total Length of Distribution and Transmission Mains (in miles)*	Average Length of Distribution and Transmission Mains per System (in miles)
State Systems	**Large CWSs**	607,400	943.2
	50,000-100,000	235,800	346.4
	10,001-50,000	617,100	162.9
	3,301-10,000	381,400	80.6
	Subtotal, Medium CWSs	1,234,300	134.1
	501-3,300	271,600	21.1
	101-500	65,500	4.4
	25-100	42,500	3.5
	Subtotal, Small CWSs	379,600	9.5
American Indian (AI) Systems	10,001-50,000	820	51.0
	3,301-10,000	4,220	74.0
	501-3,300	3,980	15.1
	101-500	800	2.7
	25-100	110	1.1
	Subtotal, AI CWSs	9,930	13.5
Alaska Native Village (ANV) Systems	3,301-10,000	100	26.0
	501-3,300	160	4.6
	101-500	190	2.0
	25-100	30	1.0
	Subtotal, ANV CWSs	480	2.9
National Total		**2,231,710**	**44.1**

Note: Exhibit includes medium system pipe length in partial participation states. See Appendix A for a discussion regarding partial participation states.

** Numbers may not total due to rounding.*

Approaches to Reporting Pipe Rehabilitation/Replacement Need

Beginning with the 2007 Assessment, EPA and the DWINSA Workgroup of state and EPA regional office representatives set a policy specific to reporting pipe rehabilitation or replacement 20-year needs. The policy allows a system to report the rehabilitation and/or replacement of up to 10 percent of its existing water mains over the 20-year period (0.5 percent annually) based on a simple statement of need. This default amount was not based on an EPA recommended replacement rate, but rather was based on the average pipe replacement rate in the U.S. If a system had 20-year water main rehabilitation/replacement needs greater than 10 percent of their existing mains, the projects would be included if independent documentation of this need was provided. The documentation could include budget and planning documents such as capital improvement plans, master plans, and project-specific design documents. Asset management plan documents could also be used if the plan has been through the critical step of water system review of asset management program outputs. Note that this pipe replacement rate assumes that pipe that is placed in the ground today will have a useful life of 200 years.

Exhibit 1.10 below presents the percentage of survey respondents that made use of the default approach and the percent of respondents that took other approaches (reported less than the default 10 percent or submitted independent documentation to support their pipe rehab/replacement needs). Exhibit 1.11 presents the percentage of need correlated to each approach.

Exhibit 1.10: System Approaches for Pipe Rehab/Replace/Replacement by Percentage of

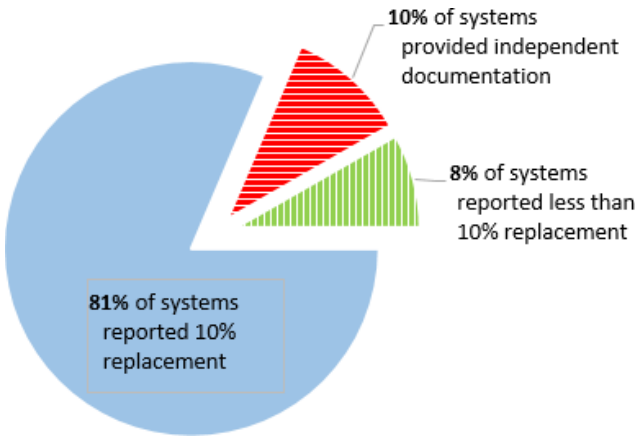
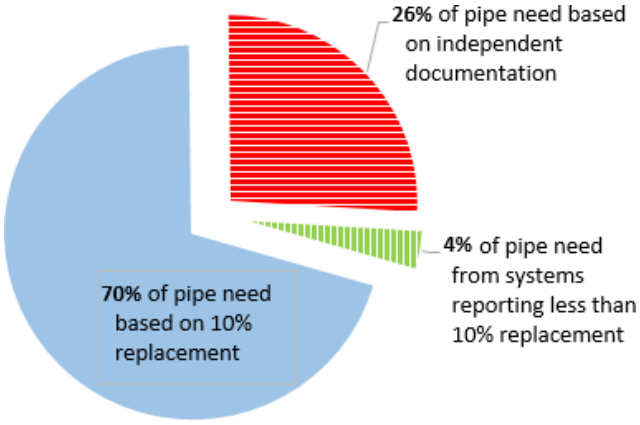


Exhibit 1.11: Pipe Rehab/Replace Need by System Approach



Note: Numbers may not total due to rounding.

60-inch transmission main for a project in Oak Lawn, IL.

Lead Service Lines

Lead service lines have become an increasing priority as issues in Flint, Michigan, have gained the nation's attention. One way lead can enter drinking water is when plumbing materials, including service pipes that contain lead corrode, especially where the water has high acidity or low mineral content.

In 1991, EPA published the Final Regulatory Impact Analysis of National Primary Drinking Water Regulations for Lead and Copper, which estimated that there were 10.2 million lead service lines in the country at that time (USEPA 1991)*. More recently, an April 2016 report in the Journal of the American Water Works Association estimated that there are currently 6.1 million lead service lines in the U.S. **

The DWINSA requests that systems identify capital infrastructure needs, which could include needs related to replacing lead service lines. However, for the purposes of the Assessment, water systems are not specifically asked to report the total number of lead service lines in their system. Based on data from large and medium systems in the 2015 Assessment and from small systems in the 2007 Assessment, water systems identified needs for replacement of approximately 1.4 million lead service lines over the 20-year period of January 2015 through December 2034. The estimated total cost of replacing these lead service lines is $4.2 billion in 2015 dollars.

Several factors likely contribute to the DWINSA estimate of the number of lead service lines needing replacement, none of which reflect EPA's perspective on the importance of this activity:

• Systems that may have lead lines but have not been experiencing lead and copper action level exceedances may not report a need for replacements.

• Systems that control lead in their drinking water through corrosion control measures may not report a need for replacements.

• Many systems address lead service lines as they are encountered in the process of rehabilitating or replacing water mains. Thus, systems may not know in advance how many lead service lines they will be replacing.

• For purposes of the needs assessment, water systems may not focus on lead service line replacement.

In the absence of project-specific data, the Assessment models the cost of lead service line replacement at $3,777/line. The cost model was derived from actual lead service line cost data submitted by water systems in past survey responses. While small compared to other needs, lead service line replacement is still a priority for many systems, and may be an increasing priority in future needs assessments as a result of heightened awareness about lead and drinking water issues.

EPA continues to work on finalizing the revisions to the Lead and Copper Rule.

*EPA. "Final Regulatory Impact Analysis of National Primary Drinking Water Regulations for Lead and Copper" (1991).

**AWWA. Journal of the American Water Works Association. "National Survey of Lead Service Line Occurrence" (Cornwell, D; Brown, A; and Via, S). (April 2016).

Treatment Needs

The total 20-year national need for treatment is estimated to be $83.0 billion. This category includes the construction, expansion, and rehabilitation of facilities to reduce contamination through treatment processes. As discussed in the Section "Needs Associated with SDWA Regulations," a large percentage of the regulatory need is in this category. Drinking water treatment facilities vary significantly depending on the quality of their source water and type of contamination addressed. Treatment systems range from a simple chlorinator for disinfection to a complete conventional treatment system with sedimentation, filtration, disinfection, laboratory facilities, waste handling, and computer automated monitoring and control devices.

The treatment category also includes projects to remove contaminants that adversely affect the taste, odor, and color of drinking water. Treatment for these "secondary contaminants" often involves softening the water to reduce magnesium and calcium levels, or applying sequestrants to chemically bind iron and manganese in order to prevent fixture discoloration, taste, or other aesthetic issues. Although not a public health concern, the aesthetic problems caused by secondary contaminants may prompt some consumers to seek more palatable, but less safe or affordable sources of water.

Increasingly, many surface water treatment systems are installing advanced treatment processes such as membrane filters and advanced oxidation to achieve drinking water quality objectives. The movement to more advanced treatment is driven by a number of factors, including customer expectations for drinking water quality; state and local requirements; or a system's own operational benchmarks.

Source Needs

The total 20-year national need for source water infrastructure is estimated at $21.8 billion. Source water needs include construction or rehabilitation of surface water intake structures, drilled wells, and spring collectors. Needs for dams and raw water reservoirs are not eligible for DWSRF funding and are therefore excluded from all Assessments since 1995 (the 1995 Assessment was completed prior to establishment of the DWSRF and its policies).

Drinking water may come from either ground water or surface water sources, and the treatment needs for removal of contaminants from these sources can differ considerably. A high-quality source water can minimize the possibility of microbial or chemical contamination and may require less treatment. Many source water needs involve construction of new surface water intake structures or drilling new wells to obtain higher-quality raw water.

A water source should provide an adequate supply to enable the water system to maintain minimum pressures. Low water pressure may result in the intrusion of contaminants into the distribution system. The 2015 Assessment includes a number of projects to expand the capacity of intake structures and add new wells to address supply deficiencies facing existing customers.

Storage Needs

The 20-year national need estimated for storage projects is $47.6 billion. This category includes projects to construct, rehabilitate, or cover finished water storage tanks, but it excludes dams and raw water reservoirs (unless the raw water basins are located at the treatment facility and are part of the treatment process) because the DWSRF regulations specifically exclude these projects from DWSRF funding. It is critical that water systems have sufficient storage to provide adequate supplies of treated water to the public, particularly during periods of peak

demand. Sufficient storage enables the system to maintain the minimum pressure required throughout the distribution system to prevent the intrusion of contaminants into the distribution network.

Other Needs

DWSRF-eligible projects that are not included in the previous four categories are grouped as "other" needs. These needs account for $7.5 billion of the total 20-year national need. Examples of "other" projects are SCADA systems for monitoring and controlling water system facility operations and emergency generators that were not assigned to another category.

New Infrastructure Needs versus Needs Associated with Existing Infrastructure

As demonstrated in Exhibit 1.12, at a national level, the needs associated with the rehabilitation, upgrade, expansion, or replacement of existing infrastructure are much larger than the DWSRF-eligible needs associated with the construction of new infrastructure (93 percent compared to 7 percent).

Exhibit 1.12: Percent of Large and Medium System Need by New vs. Existing Infrastructure and by Project Category*

	Existing Infrastructure (Rehabilitation, Expansion/Upgrade, Replacement)	New Infrastructure (DWSRF-eligible Only)
Source	75%	25%
Treatment	91%	9%
Storage	90%	10%
Pipe	94%	6%
T&D Needs other than Pipe†	96%	4%
Other Needs‡	87%	13%
Overall	**93%**	**7%**

* Percentages represent the needs of large systems and medium systems surveyed in 2015. It does not include the needs of medium systems in partial participation states (discussed in Appendix A), small systems, not-for-profit noncommunity systems, American Indian systems, or Alaska Native Village systems.

† Transmission and Distribution (T&D) needs other than pipe include infrastructure such as pump stations, valves, meters, backflow prevention, and service lines.

‡ Includes infrastructure such as system-wide SCADA or emergency generators not specifically associated with another need category.

There is more existing infrastructure that must be rehabilitated or replaced to maintain their reliable function over the 20-year Assessment period than new infrastructure needed to address a deficiency. In addition, the Assessment does not include needs for new infrastructure projects that are driven by needs that are not DWSRF-eligible, such as anticipated population growth.

Projects for rehabilitation, replacement, upgrade, or expansion are commonly intended to address age and deterioration of a water system's existing infrastructure. Projects for new infrastructure are generally driven by a

need for system expansion such as a new storage tank to address pressure deficiencies or a new water main to loop water distribution system dead end lines to reduce stagnation. Projects for new infrastructure to accommodate anticipated growth or for fire suppression are not eligible for DWSRF funding and are not included in the DWINSA estimate of need. The need for replacement or rehabilitation of water systems' existing infrastructure has continued to increase relative to the needs for new infrastructure, resulting in the overall increase in total national needs in 2015.

It should be noted that the needs for individual systems and states can vary from the overall national findings. For example, the survey results find that nationally, the need for new pipe is just 6 percent of the total pipe-related need; however, one wholesale system documented a need for new pipe that represents 52 percent of its total need. That system uses surface water as its primary source and reported a significant need to extend new water transmission lines to neighboring communities where ground water withdrawals have caused subsidence problems. This system's need for new pipelines contributed substantially to the state's high percentage of new pipe need (15 percent of the total pipe need in the state). See Chapter 2 for more discussion regarding need at the state level.

Need by System Size

Exhibit 1.13 shows the distribution of infrastructure need by community water system size and total population served. As this exhibit shows, the very small number of large community water systems serve a large portion of the U.S. population (46.4 percent) but account for a smaller percentage (37.6 percent) of the overall drinking water infrastructure investment need, reflecting the economies-of-scale in large drinking water systems. Conversely, the very large number of small community water systems serve only 7.8 percent of the U.S. population, but account for a disproportionate percentage (16.5 percent) of the CWS need. Medium community water systems represent the largest portion of the need (45.8 percent), and their need is proportional to the population served (45.8 percent).

American Indian and Alaska Native Village communities are included in Exhibit 1.13. These systems serve primarily small communities. For example, the 2011 Assessment found that approximately 90 percent of the 791 American Indian water systems served fewer than 3,300 people. Similarly, for Alaska Native Villages, in 2011 all but four of the 165 systems served 3,300 or fewer people and none served over 10,000 people.

Exhibit 1.13: Community Water System 20-year Need by Size and Population (in billions of January 2015 dollars)

System Size*	Need		Water Systems†		Total Population Served	
	$ Billions	% of Need	Number of Systems	% of Water Systems	Population (millions)‡	% of Population Served§
Large Community Water Systems (serving over 100,000 people)	$174.4	37.6%	644	1.3%	141.7	46.4%
Medium Community Water Systems (serving 3,301 to 100,000 people)	$212.3	45.8%	9,279	18.7%	140.1	45.8%
Small Community Water Systems (serving 3,300 and fewer people)	$76.6	16.5%	39,482	79.9%	23.9	7.8%

Note: Percentages may not add to 100 due to rounding.

* This exhibit reports the needs for community water systems in the states, Washington D.C., Puerto Rico, the U.S. territories, American Indian systems, and Alaska Native Village systems. It does not include findings for not-for-profit noncommunity water systems.

† Based on the 2015 DWINSA sample frame for state-regulated systems and the 2011 DWINSA sample frame for American Indian and Alaska Native Village systems.

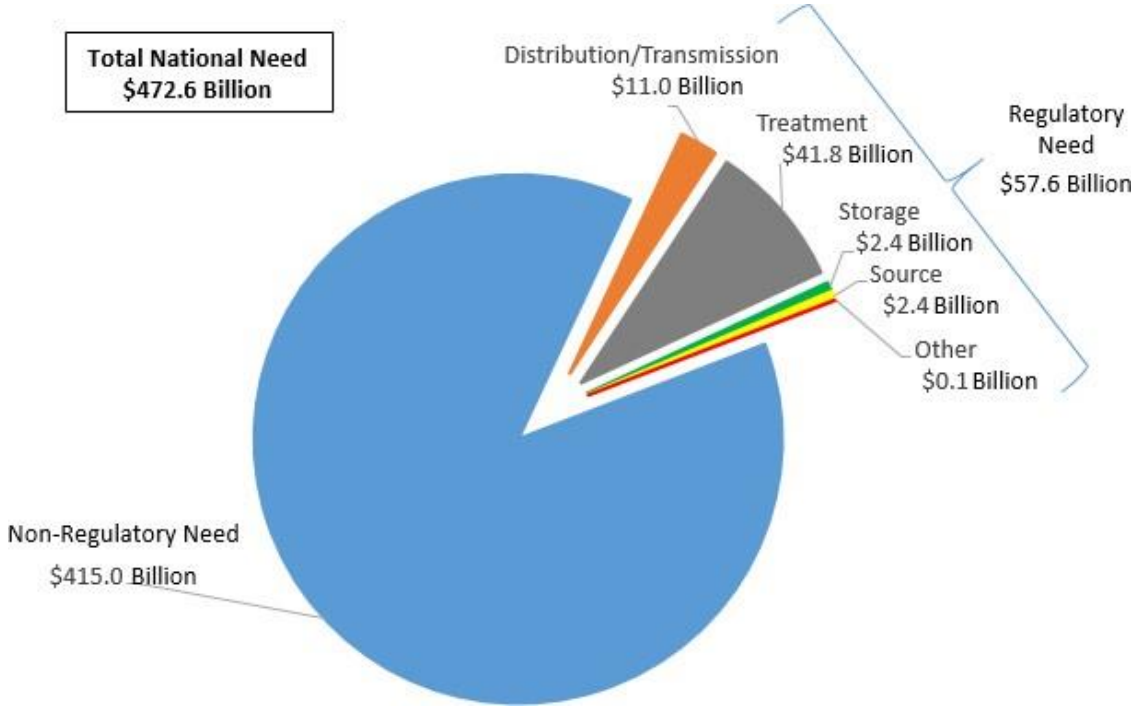
‡ Population was derived on 12/8/2016 from EPA's SDWIS Federal Reports website: https://ofmpub.epa.gov/apex/sfdw/f?p=108:1:::NO:1. The information is for community water systems only and includes populations for American Indian and Alaska Native Village water systems. It does not include populations for systems defined as "Federal Systems," which are not eligible for the DWSRF.

§ Values are a percentage of the population that is served by CWSs. Does not include homes served by other sources such as individual wells or small multi-family supplies.

Needs Associated with SDWA Regulations

As shown in Exhibit 1.14, just over 12 percent of the total national drinking water infrastructure need ($57.6 billion), is related to compliance with the SDWA regulations. Projects that are directly attributable to specific SDWA regulations are collectively referred to as the "regulatory need." Many infrastructure improvements are to ensure a reliable supply of safe water is provided and are not directly linked to a particular regulatory requirement, although they facilitate to compliance. Most of the regulatory need involves the upgrade, replacement, or installation of treatment technologies. Of the $57.6 billion of regulatory need, $41.8 billion is related to treatment; while $11.0 billion, $2.4 billion, $2.4 billion, and $0.1 billion are related to the distribution and transmission, storage, source, and 'other' categories, respectively.

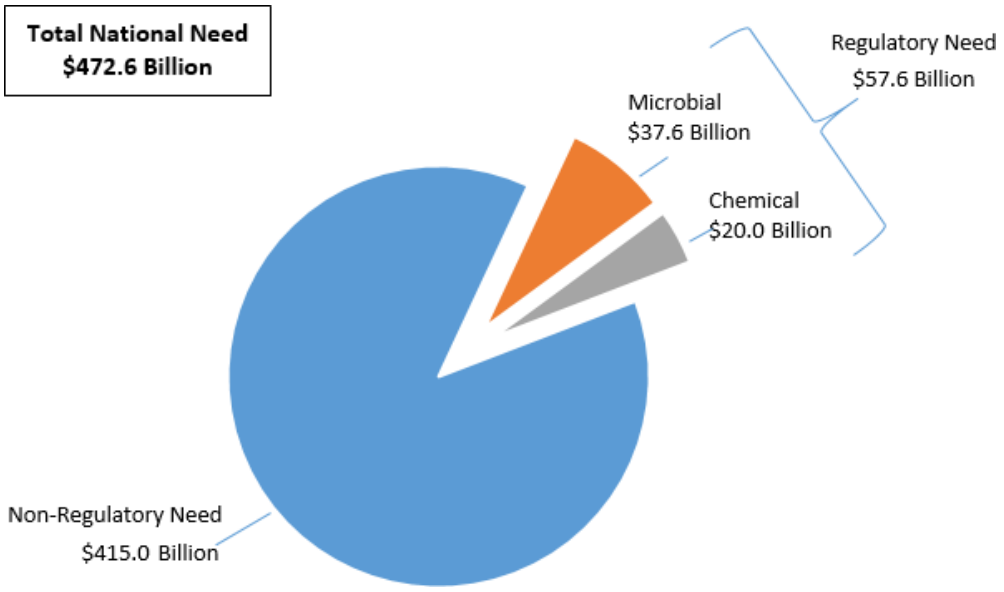
Exhibit 1.14: Total Regulatory vs. Non-Regulatory 20-year Need (in billions of January 2015 dollars)



Note: Numbers may not total due to rounding.

The Assessment divides the regulatory need into microbial and chemical regulations. Exhibit 1.15 presents the regulatory needs by these categories and compares the regulatory need with non-regulatory 20-year need. Note that the need associated with the 1999 Proposed Radon Rule is included in the chemical category.

Exhibit 1.15: Total Regulatory Need by Microbial and Chemical Regulations vs. Non-Regulatory 20-year Need (in billions of January 2015 dollars)



Note: Needs associated with the Proposed Radon Rule are included in chemical regulations.

Existing Regulatory Needs

The infrastructure needs associated with water systems complying with existing EPA regulations are identified through the completed survey questionnaires. The reported infrastructure needs associated with existing regulations are reflected in the needs previously presented by system size, project category, and total need.

Existing Regulations for Microbial Contaminants

The surface water treatment regulations (Surface Water Treatment Rule, Interim Enhanced Surface Water Treatment Rule, Filter Backwash Recycling Rule, Long Term 1 Enhanced Surface Water Treatment Rule, and Long Term 2 Enhanced Surface Water Treatment Rule), the Revised Total Coliform Rule, and the Ground Water Rule are existing SDWA regulations that address microbial contamination. The Stage 1 and Stage 2 Disinfectants/Disinfection Byproducts Rules regulate the disinfectant and disinfection byproduct levels in distribution systems and are grouped with the microbial rules.

Projects for compliance with microbial regulations account for 69 percent of the total regulatory need. Under these regulations, systems using surface water sources must provide treatment to minimize microbial contamination. In most cases, this means installing, upgrading, or rehabilitating treatment plants to control dangerous human pathogens such as the bacterium *E. coli*, the virus Hepatitis A, and the protozoans *Giardia lamblia* and *Cryptosporidium*.

Existing Regulations for Chemical Contaminants

This category includes regulations governing more than 80 inorganic or organic drinking water contaminants for which infrastructure projects may be needed. This estimate includes projects intended to help systems comply with the Nitrate/Nitrite Standard, the revised Arsenic Standard, the Lead and Copper Rule, and other regulations

that set maximum contaminant levels or treatment techniques for organic and inorganic chemicals. Examples of these projects include installation of aerators to remove volatile organic compounds or ion exchange units to remove inorganic contaminants from the water. This category also includes projects that are required to address secondary standards such as iron, manganese, hardness, taste and odor. Examples of these projects include oxidation/filtration to remove iron and/or manganese, softening to remove hardness, and distribution projects to address water quality issues such as stagnant water.

Proposed or Recently Promulgated Regulatory Needs

In general, water systems can readily identify the infrastructure needs required for compliance with existing regulations, but systems typically have not accounted for the infrastructure needed to comply with regulations that are in proposed status or that have been recently promulgated at the time of data collection. Consequently, for these needs, EPA derives the capital infrastructure estimates from the Economic Analysis (EA) that the Agency published when proposing each regulation, or from the final EA if the regulation has been recently promulgated. The only regulation that was in this category for the 2015 Assessment is the 1999 Proposed Radon Rule. The total cost of complying with the Proposed Radon Rule, estimated to be $4.2 billion (in January 2015 dollars), is included in the Assessment as a regulatory need in the treatment and chemical contaminant categories. Because the EAs rely on regional data, they are not appropriate predictors of state-specific needs. Therefore, the costs associated with the Proposed Radon Rule are allocated at a national level, not apportioned to each state.

Well rehabilitation site in Peoria, AZ.

Asset Management

Understanding the Trade-Off between Capital and Operating Expenditures

The cost to the customer of safe drinking water provided by community water systems in the U.S. is typically far lower than the water systems' cost to provide that service to their customers. The true cost of providing safe drinking water may be misunderstood, as much of the infrastructure is hidden from view. The typical drinking water utility has seven times more asset value than annual operating income. *

Customers expect a water utility to deliver high quality water, in as much quantity as needed, at adequate pressures, and without interruption. Maintaining that level of service requires ongoing reinvestment to replace infrastructure that has reached the end of its useful life. Avoiding such reinvestments will result in increasing operation and maintenance expense or a significant increase in system failures.

Well managed utilities implement asset management programs to help them make prudent, economically justified decisions regarding capital investment. The age of pipe alone is a poor indicator of the need for that pipe to be replaced. Through asset management, utilities document the condition and failure history of their piping network and other assets. Over time, these utilities can confidently predict the likely remaining useful life in their assets. In some cases, utilities will find that they need to replace pipe sooner than age would suggest, while in other cases, they will find that pipe can be expected to provide many more years of service despite its age.

As a result of implementing asset management, some utilities are documenting larger capital investment needs than they had previously anticipated. Others are finding that there is greater remaining useful life in their assets than they had previously assumed. Deciding when to replace a given length of pipe ultimately depends upon a utility's target level of service and the risk the utility accepts of that particular section of pipe failing. The target level of service for the entire utility may incorporate differing levels of failure risk for different components of their distribution system. Pipe serving a hospital or other critical infrastructure may be managed to a lower risk of failure than will pipe serving a commercial area.

Many utilities are only in the very early stages of developing an asset management program, as evidenced by the reliance of most survey respondents on the survey's baseline pipe replacement rate. That baseline rate of 0.5 percent per year, or 10 percent over 20 years, reflects the current documented rate of replacement of pipe within the drinking water industry. A 0.5 percent per year replacement rate imputes a 200-year life to pipe.

* Water Research Foundation and U.S. Environmental Protection Agency; Improving Water Utility Capital Efficiency; 2009 Page 10

Chapter 2: Findings - State Need

State-Specific Needs

Since federal fiscal year 1998, the SDWA has required EPA to allot DWSRF grants to each state based on the findings of the most recent Assessment. Given the critical role of this Assessment in determining DWSRF capitalization grant allocations, obtaining highly credible and statistically valid estimates of each state's need is essential. Exhibits 2.1 and 2.2 show the total DWSRF-eligible need for states, Puerto Rico, the District of Columbia, and the U.S. territories by project category and system size. Exhibit 2.3 is a map indicating each state's 20-year total need.

DWSRF capitalization grants for fiscal years 2018 through 2021 will be allocated to states based on the findings of the 2015 Assessment. The funding is allocated by first setting aside a percentage allotment to American Indian and Alaska Native Village water systems (most recently set at 2.0 percent), and a percent allotment to the U.S. territories, including the U.S. Virgin Islands, Guam, the Commonwealth of the Northern Mariana Islands, and American Samoa (most recently 1.5 percent). The Assessment findings are used to help divide these set-asides among these entities. The remaining funds are then divided among the states, Puerto Rico, and the District of Columbia, based on the determination of each state's relative percentage of the total "state need," with each receiving no less than the 1 percent minimum allotment.

States that received the minimum allotment of 1 percent in the most recent allocation were given the option of a lower level of participation in the Assessment. As discussed below, only the large systems in these states were surveyed, and data were not collected for medium sized systems. This option was provided to reduce the burden on these states and allow for resources to be focused on the large systems. These states' needs are reported as one group referred to as "partial participation" states.

Partnership for Determining State Need

The substantial effort involved in collecting data and calculating water systems' 20-year needs relies on a partnership between EPA, the states, and the utilities themselves. Each partner makes a valuable contribution to estimating the DWSRF-eligible needs of drinking water systems.

- Water System. Operators and managers of water utilities have extensive on-the-ground knowledge of their system's infrastructure and condition. These personnel are in the best position to assess their infrastructure needs.

- States. State personnel have considerable knowledge of the systems in their state, and states have the staff that are trained to assist systems in completing this Assessment. As DWINSA workgroup members, the states also work with EPA towards consensus development of Assessment policies and methods to ensure consistency across the states.

- EPA. EPA's primary roles are to serve as the quality assurance agent for the data collection effort, to ensure that survey policies and methodologies are met, and to serve as a technical resource to assist with capturing complete and accurate 20-year needs. EPA provides oversight for survey submittals to encourage full reporting, to ensure consistency and fairness between states, and to control for any state bias.

Exhibit 2.1: State 20-year Need Reported by Project Category (in millions of January 2015 dollars)

State	Transmission and Distribution	Treatment	Storage	Source	Other	Total
Alabama	$8,942.6	$1,097.5	$815.8	$193.6	$212.2	$11,261.9
Arizona	$5,837.1	$1,655.2	$1,042.2	$393.6	$202.4	$9,130.5
Arkansas	$5,461.2	$900.0	$643.4	$216.5	$155.7	$7,376.8
California	$31,685.9	$9,199.4	$6,967.2	$2,565.4	$615.2	$51,033.2
Colorado	$6,166.4	$2,722.4	$924.3	$228.4	$147.1	$10,188.7
Connecticut	$2,542.1	$770.4	$400.9	$187.6	$116.7	$4,017.7
District of Columbia	$1,573.8	$62.9	$104.5	$0.0	$0.7	$1,741.9
Florida	$13,734.0	$4,702.5	$1,551.6	$1,446.2	$452.2	$21,886.4
Georgia	$9,362.6	$1,676.8	$973.7	$365.4	$81.7	$12,460.1
Illinois	$13,494.8	$3,537.2	$1,751.0	$1,709.1	$418.2	$20,910.4
Indiana	$5,056.2	$1,198.1	$704.6	$430.2	$131.1	$7,520.2
Iowa	$5,858.5	$945.5	$607.1	$376.2	$65.1	$7,852.4
Kansas	$3,727.9	$870.5	$442.0	$235.2	$47.1	$5,322.6
Kentucky	$6,320.7	$929.7	$648.8	$206.7	$126.2	$8,232.0
Louisiana	$5,117.5	$1,064.7	$644.9	$333.0	$170.5	$7,330.6
Maine	$883.3	$198.2	$181.6	$72.6	$12.7	$1,348.3
Maryland	$6,959.4	$1,243.2	$810.1	$271.2	$46.1	$9,330.1
Massachusetts	$8,601.4	$1,850.6	$1,184.3	$330.7	$277.4	$12,244.4
Michigan	$9,084.7	$2,130.7	$1,042.0	$553.8	$235.0	$13,046.2
Minnesota	$4,416.6	$1,398.7	$912.3	$581.9	$198.4	$7,507.9
Mississippi	$3,090.2	$775.5	$561.2	$331.9	$64.4	$4,823.2
Missouri	$6,302.2	$1,305.1	$907.0	$374.3	$30.2	$8,918.9
Nevada	$2,844.4	$1,083.6	$454.3	$894.3	$40.2	$5,316.8
New Jersey	$5,381.1	$1,774.3	$888.5	$413.1	$126.1	$8,583.1
New York	$14,643.4	$3,974.7	$2,835.0	$1,035.2	$277.6	$22,765.9
North Carolina	$11,803.7	$2,453.2	$1,327.7	$786.7	$350.9	$16,722.2
Ohio	$8,970.4	$2,330.8	$1,258.5	$571.8	$273.9	$13,405.4
Oklahoma	$4,805.1	$1,043.4	$625.4	$258.7	$126.3	$6,858.9
Oregon	$3,742.4	$1,084.7	$1,022.2	$298.1	$103.0	$6,250.4
Pennsylvania	$11,134.2	$2,787.9	$1,881.9	$617.2	$350.3	$16,771.6
Puerto Rico	$2,201.9	$921.1	$397.6	$124.1	$59.5	$3,704.2
South Carolina	$4,555.9	$855.9	$418.4	$181.6	$115.6	$6,127.4
Tennessee	$6,774.7	$1,179.5	$672.4	$130.8	$6.4	$8,763.7
Texas	$30,485.1	$8,309.3	$4,090.2	$1,545.4	$721.3	$45,151.3
Utah	$2,354.1	$948.4	$701.5	$267.0	$83.4	$4,354.4
Virginia	$5,588.6	$1,341.3	$847.5	$216.4	$141.2	$8,135.2
Washington	$7,262.5	$1,763.0	$1,636.8	$728.6	$338.4	$11,729.4
Wisconsin	$5,324.9	$1,601.5	$1,037.9	$528.8	$76.1	$8,569.2
Partial Participation States*	$17,532.5	$4,360.1	$3,025.7	$1,534.8	$407.2	$26,860.3
Subtotal	**$309,624.2**	**$78,047.8**	**$46,941.6**	**$21,536.5**	**$7,403.6**	**$463,553.8**
American Samoa	$210.4	$49.7	$23.0	$18.1	$1.2	$302.5
Guam	$97.4	$44.3	$70.5	$27.5	$30.3	$270.0
Northern Mariana Is.	$112.1	$41.7	$26.7	$14.2	$3.6	$198.4
Virgin Islands	$154.5	$12.1	$57.0	$8.4	$3.1	$235.1
Subtotal	**$574.4**	**$147.8**	**$177.2**	**$68.1**	**$38.2**	**$1,005.9**
Total	**$310,198.6**	**$78,195.6**	**$47,118.9**	**$21,604.7**	**$7,441.9**	**$464,559.6**

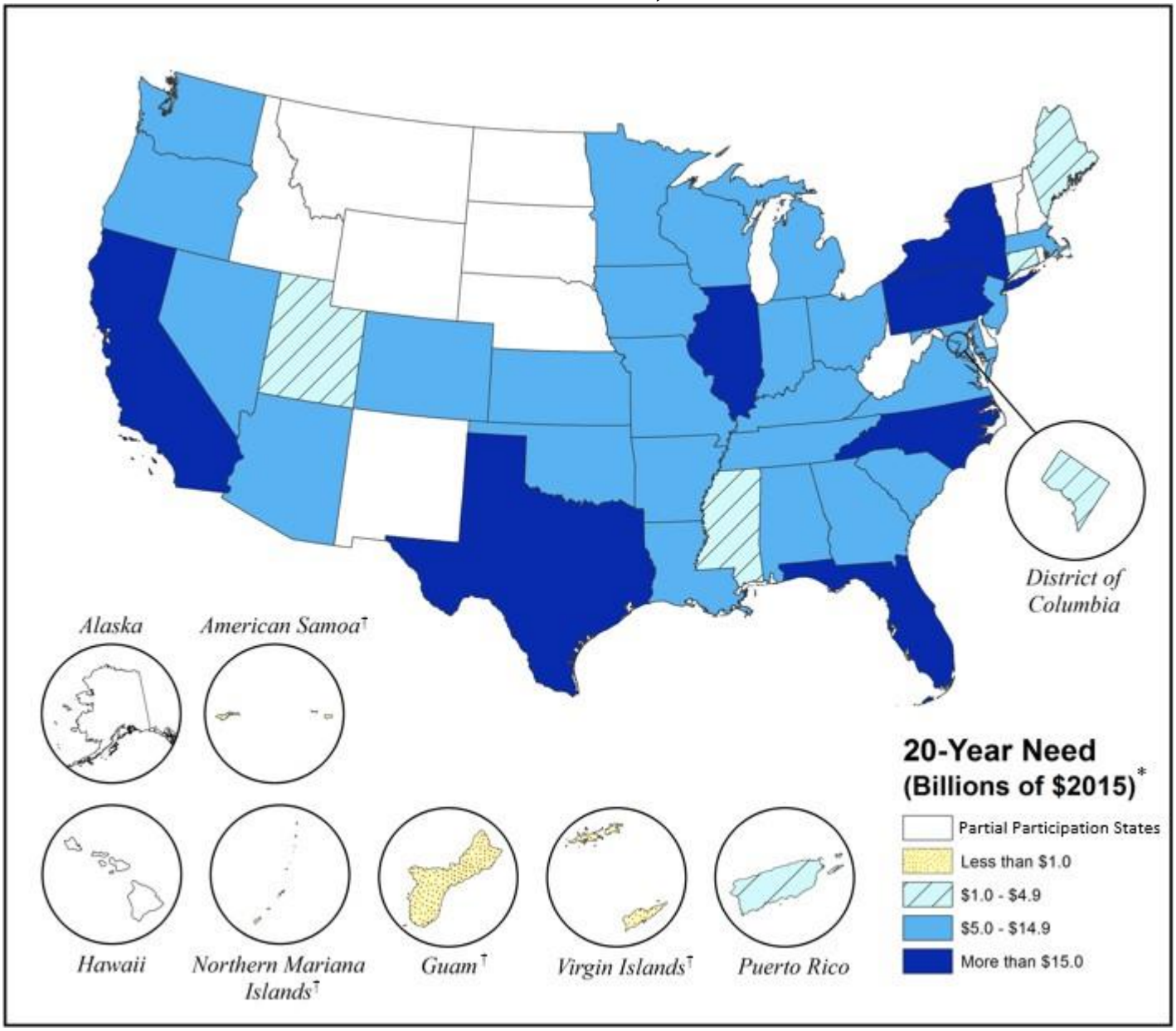
* The needs for partial participation states (discussed in Appendix A) are presented cumulatively and not by state. The list of 14 partial participation states is shown in Exhibit 2.4.

Exhibit 2.2: State 20-year Need Reported by System Size (in millions of January 2015 dollars)

State	Large	Medium	Small	NPNCWSs	Total
Alabama	$2,813.8	$8,062.1	$381.2	$4.8	$11,261.9
Arizona	$5,039.5	$3,035.1	$1,032.5	$23.4	$9,130.5
Arkansas	$977.3	$5,219.9	$1,170.4	$9.2	$7,376.8
California	$32,942.7	$13,520.4	$4,441.8	$128.3	$51,033.2
Colorado	$3,874.7	$4,850.0	$1,462.3	$1.6	$10,188.7
Connecticut	$1,807.2	$1,412.2	$763.5	$34.8	$4,017.7
District of Columbia	$1,741.9	$0.0	$0.0	$0.0	$1,741.9
Florida	$11,399.3	$8,239.0	$2,086.5	$161.6	$21,886.4
Georgia	$4,400.6	$5,969.9	$2,072.2	$17.4	$12,460.1
Illinois	$5,767.1	$11,688.8	$3,315.1	$139.4	$20,910.4
Indiana	$1,794.1	$4,227.5	$1,275.4	$223.2	$7,520.2
Iowa	$448.8	$5,559.5	$1,820.8	$23.3	$7,852.4
Kansas	$1,285.7	$2,387.6	$1,645.0	$4.4	$5,322.6
Kentucky	$1,717.1	$6,040.2	$473.3	$1.4	$8,232.0
Louisiana	$1,251.8	$4,508.9	$1,551.0	$18.9	$7,330.6
Maine	$158.9	$566.6	$579.2	$43.6	$1,348.3
Maryland	$7,388.0	$1,116.9	$700.9	$124.3	$9,330.1
Massachusetts	$2,900.2	$8,758.8	$543.8	$41.6	$12,244.4
Michigan	$4,882.4	$5,509.9	$2,056.3	$597.6	$13,046.2
Minnesota	$1,110.0	$4,322.9	$1,735.5	$339.5	$7,507.9
Mississippi	$245.8	$2,500.5	$2,064.8	$12.1	$4,823.2
Missouri	$2,334.4	$4,141.9	$2,393.0	$49.5	$8,918.9
Nevada	$3,964.0	$1,010.2	$324.5	$18.0	$5,316.8
New Jersey	$3,612.9	$3,968.8	$743.9	$257.6	$8,583.1
New York	$11,720.7	$6,506.6	$4,378.9	$159.7	$22,765.9
North Carolina	$4,772.4	$9,302.6	$2,179.4	$467.9	$16,722.2
Ohio	$5,031.9	$6,102.9	$1,913.4	$357.1	$13,405.4
Oklahoma	$1,296.3	$3,669.5	$1,864.9	$28.2	$6,858.9
Oregon	$1,761.0	$3,026.6	$1,392.4	$70.3	$6,250.4
Pennsylvania	$6,809.5	$6,378.1	$3,227.4	$356.6	$16,771.6
Puerto Rico	$1,173.7	$1,816.9	$712.0	$1.6	$3,704.2
South Carolina	$1,643.7	$3,779.1	$684.1	$20.5	$6,127.4
Tennessee	$2,048.3	$6,131.3	$547.7	$36.4	$8,763.7
Texas	$19,374.0	$18,850.6	$6,866.5	$60.3	$45,151.3
Utah	$1,269.2	$2,403.6	$665.2	$16.4	$4,354.4
Virginia	$3,114.0	$3,360.0	$1,545.1	$116.0	$8,135.2
Washington	$2,969.3	$5,593.8	$3,019.4	$146.9	$11,729.4
Wisconsin	$2,393.7	$3,881.4	$1,682.3	$611.8	$8,569.2
Partial Participation States*	$4,856.3	$12,682.9	$8,898.3	$422.9	$26,860.3
Subtotal	**$174,092.1**	**$210,103.5**	**$74,210.0**	**$5,148.2**	**$463,553.8**
American Samoa	$0.0	$250.3	$52.2	$0.0	$302.5
Guam	$270.0	$0.0	$0.0	$0.0	$270.0
Northern Mariana Is.	$0.0	$113.3	$85.1	$0.0	$198.4
Virgin Islands	$0.0	$162.9	$72.2	$0.0	$235.1
Subtotal	**$270.0**	**$526.5**	**$209.4**	**$0.0**	**$1,005.9**
Total	**$174,362.0**	**$210,630.0**	**$74,419.4**	**$5,148.2**	**$464,559.6**

* The needs for partial participation states (discussed in Appendix A) are presented cumulatively and not by state. The list of 14 partial participation states is shown in Exhibit 2.4.

Exhibit 2.3: Overview of 20-year Need by State (including District of Columbia, Puerto Rico and U.S. Territories)



Note: Map does not include needs for American Indian and Alaska Native Village water systems.
* The list of the 14 partial participation states can be found in Exhibit 2.4.
† The needs for American Samoa, Guam, the Commonwealth of the Northern Mariana Islands, and the U.S. Virgin Islands are less than $1 billion each.

States that received the minimum DWSRF allotment of 1 percent in the most recent allocation were given the option of surveying only the large systems in their states and not collecting data for medium systems. (Small system data were collected by EPA in the 2007 Assessment.) This option was provided to reduce the burden on these states and allow for resources to be focused on the large systems. Of the 19 states (including the District of Columbia and Puerto Rico) that received the minimum allocation based on the 2011 Assessment findings, 14 chose this "partial participation" option. For these states, the medium system need was estimated based on data from fully surveyed states. Because this method does not meet the Assessment's stringent data quality objectives at the state level, the needs of these states contribute to the estimate of the total national need but are not reported individually by state. Exhibit 2.4 shows the large system need and small system need (extrapolated from the 2007 Assessment) estimated by state, and the total medium system need for the partial participation states.

Exhibit 2.4: State 20-year Need Reported for Partial Participation States (in millions of January 2015 dollars)

State	Large	Medium*	Small†	NPNCWSs‡	Total
Alaska	$472.7		$436.4	$77.3	$986.5
Delaware	$447.9		$354.3	$4.1	$806.3
Hawaii	$961.5		$192.0	$1.3	$1,154.8
Idaho	$265.7		$989.7	$47.8	$1,303.1
Montana	$139.9		$946.5	$64.1	$1,150.5
Nebraska	$625.6		$992.0	$20.2	$1,637.8
New Hampshire	$70.6		$864.4	$78.4	$1,013.3
New Mexico	$561.2		$775.8	$19.5	$1,356.4
North Dakota	$208.6		$500.0	$6.7	$715.4
Rhode Island	$715.2		$97.4	$20.4	$833.0
South Dakota	$133.5		$589.8	$6.4	$729.7
Vermont	$0.0		$642.7	$0.2	$642.9
West Virginia	$253.8		$1,074.8	$61.0	$1,389.6
Wyoming	$0.0		$442.6	$15.5	$458.1
Total	**$4,856.3**	**$12,682.9**	**$8,898.3**	**$422.9**	**$26,860.3**

* The medium community water system need was estimated cumulatively based on data from fully surveyed states.

† The small system need is based on the 2007 Assessment findings adjusted to 2015 dollars, an updated inventory, and updated cost models.

‡ The not-for-profit noncommunity water system need is based on the 1999 Assessment findings adjusted to 2015 dollars.

More of the need of the partial participation states is for their small and medium systems than their large systems, which reflects that these states generally have few systems serving more than 100,000 people. This finding also applies to some full-participation states with few large systems relative to the number of medium and small systems or no very large systems that serve over 1 million people.

Needs of Water Systems in U.S. Territories

Under SDWA and through appropriations, 1.5 percent of DWSRF monies are allocated to the U.S. territories (American Samoa, the Commonwealth of the Northern Mariana Islands, Guam, and the U.S. Virgin Islands) to be used as grants for water systems. To assess the needs of water systems in U.S. territories, EPA collected data from all medium and large systems in the 2015 Assessment and used the findings from the 2007 Assessment to

estimate the needs of small systems. Exhibit 2.5 shows the 20-year need reported for each of the U.S. territories in millions of January 2015 dollars.

Exhibit 2.5: 20-year Need Reported by U.S. Territories (in millions of January 2015 dollars)

Territory	Total Need
American Samoa	$302.5
Guam	$270.0
Commonwealth of the Northern Mariana Islands	$198.4
U.S. Virgin Islands	$235.1

The Assessments have consistently demonstrated that water systems in the territories face unique challenges in providing safe drinking water to their customers. As made clear in their survey submissions and supporting documentation, while drinking water issues can vary from island to island, the overall challenges for all the U.S. territories include rapidly deteriorating infrastructure, a seasonal transient customer base, limited source water options, and ground water contamination.

Changes in State-Specific Need through Assessment Cycles

The state-specific results of the Assessments show that states' needs change, some more significantly than others, during the four-year intervals between Assessments (see Exhibit 2.6). State-specific changes from one Assessment to the next as well as needs relative to each other can be attributed to two primary factors:

Changes in Projects Planned, Initiated, and Completed. Congress specified that the DWINSA be repeated at 4-year intervals to capture changes in system infrastructure needs. Changes in the reported needs of individual systems from one Assessment period to the next can have a significant effect on the overall state need. For example, in one Assessment a large system that has identified a project with very substantial costs might cause that state's need to increase due to the large project. However, if construction of the project begins prior to the next Assessment cycle, those needs would not be included in the next Assessment. If all other needs in that state were to remain constant, the state's need would be lower for the next Assessment. In addition, conditions such as drought or other momentous events that affect water systems within a state may change significantly over a four-year period and have an impact on that state's need from projects planned to mitigate or address the event.

Changes in National and State Assessment Approaches. State-specific needs have also been affected by changes in the Assessment methodology since the first initial effort in 1995. The Assessment's "bottom-up" approach of receiving documented needs on a project-by-project basis for each system has remained essentially unchanged, and the general statistical approach of stratified random sampling of water systems has also remained unchanged, with the exception of applying the panel approach to medium system samples in full participation states in this 2015 DWINSA (as described in Appendix B).

However, since the first effort in 1995, changes to the Assessment's general policies and procedures have affected individual states' infrastructure needs, both in terms of their total state need and their relative share of the total national need. Changes have been made to the types of parties responsible for data collection, the type of documentation required to support acceptance of an identified need, and policies and approaches implemented to further ensure both complete and high-quality data collection. The evolving methodology over the last 20 years, from 1995 to 2015, is further detailed in Appendix A and Appendix B.

Exhibit 2.6: Historic State Need Reported for Each Assessment (20-year need in millions of January 2015 dollars)

State	1995	1999	2003	2007	2011	2015
Alabama	$3,040	$1,796	$2,559	$5,188	$8,869	$11,262
Alaska	$1,413	$973	$1,033	$1,028	*	*
Arizona	$2,480	$2,696	$13,819	$9,378	$8,301	$9,131
Arkansas	$3,709	$2,550	$5,362	$6,680	$6,804	$7,377
California	$34,469	$29,067	$42,233	$49,412	$49,663	$51,033
Colorado	$3,571	$4,206	$8,067	$8,099	$7,948	$10,189
Connecticut	$2,486	$1,673	$990	$1,764	$3,992	$4,018
Delaware	$681	$505	$365	*	*	*
District of Columbia	$241	$688	$226	$1,106	$1,793	$1,742
Florida	$7,943	$6,190	$22,791	$16,227	$18,376	$21,886
Georgia	$6,036	$3,999	$13,664	$11,311	$10,340	$12,460
Hawaii	$789	$244	$1,231	*	*	*
Idaho	$1,081	$857	$1,102	*	*	*
Illinois	$9,801	$10,221	$20,451	$19,004	$21,181	$20,910
Indiana	$3,068	$2,815	$6,109	$7,523	$7,304	$7,520
Iowa	$4,133	$4,731	$5,309	$7,736	$6,616	$7,852
Kansas	$3,621	$2,735	$2,926	$5,100	$4,680	$5,323
Kentucky	$4,075	$2,941	$4,256	$6,300	$6,949	$8,232
Louisiana	$3,579	$2,115	$6,223	$8,732	$5,938	$7,331
Maine	$1,586	$829	$1,260	*	$1,316	$1,348
Maryland	$2,354	$2,777	$6,005	$6,889	$7,713	$9,330
Massachusetts	$10,892	$9,767	$12,963	$8,593	$8,592	$12,244
Michigan	$8,129	$11,282	$17,139	$14,987	$15,412	$13,046
Minnesota	$4,466	$5,151	$8,274	$7,578	$8,214	$7,508
Mississippi	$2,888	$2,262	$2,492	$4,104	$4,113	$4,823
Missouri	$3,442	$3,623	$9,028	$8,967	$9,462	$8,919
Montana	$1,214	$1,449	$1,196	*	*	*
Nebraska	$1,746	$1,383	$2,052	$2,248	*	*
Nevada	$962	$1,001	$1,382	$3,406	$6,238	$5,317
New Hampshire	$1,314	$830	$902	*	*	*
New Jersey	$6,620	$6,081	$10,479	$10,075	$8,830	$8,583
New Mexico	$1,910	$1,732	$1,397	*	*	*
New York	$18,472	$21,864	$22,445	$34,342	$24,591	$22,766
North Carolina	$4,972	$4,499	$16,638	$12,725	$11,208	$16,722
North Dakota	$1,075	$814	$920	*	*	*
Ohio	$8,989	$8,242	$14,674	$15,944	$13,602	$13,405
Oklahoma	$3,722	$3,890	$7,280	$5,204	$7,245	$6,859
Oregon	$3,936	$4,503	$6,467	$3,525	$6,207	$6,250
Pennsylvania	$8,713	$8,739	$16,653	$14,400	$15,873	$16,772

State	1995	1999	2003	2007	2011	2015
Puerto Rico	$4,130	$3,277	$3,453	$3,211	$3,583	$3,704
Rhode Island	$1,203	$959	$610	*	*	*
South Carolina	$2,676	$1,364	$1,887	$2,061	$0	$6,127
South Dakota	$1,042	$731	$1,500	*	*	*
Tennessee	$3,428	$2,344	$4,198	$4,489	$3,003	$8,764
Texas	$22,653	$21,718	$42,685	$33,068	$37,813	$45,151
Utah	$1,915	$854	$1,071	*	$4,157	$4,354
Vermont	$841	$510	$598	*	*	*
Virginia	$5,393	$3,416	$4,341	$7,671	$7,493	$8,135
Washington	$7,385	$6,561	$10,109	$12,346	$10,621	$11,729
West Virginia	$1,997	$1,695	$1,306	*	*	*
Wisconsin	$3,421	$5,149	$8,998	$7,828	$7,967	$8,569
Wyoming	$716	$735	$452	*	*	*
Partial Participation States*				$21,757	$26,735	$26,860
Subtotal	**$250,416**	**$231,032**	**$399,571**	**$410,005**	**$418,745**	**$463,554**
American Samoa	$41	$60	$49	$117	$91	$302
Guam	$195	$191	$423	$334	$263	$270
North Mariana Is.	$64	$124	$300	$366	$198	$198
Virgin Islands	$409	$269	$273	$321	$195	$235
Subtotal	**$710**	**$644**	**$1,045**	**$1,138**	**$747**	**$1,006**
Total	**$251,126**	**$231,676**	**$400,616**	**$411,144**	**$419,492**	**$464,560**

Note: This table represents needs of state systems only; needs of American Indian and Alaska Native Village water systems are reported in Chapter 3. In addition, this table does not include needs associated with proposed or recently promulgated regulations.

* For the 2007, 2011, and 2015 Assessments, the need for partial participation states (discussed in Appendix A) that opted out of the medium system portion of the survey is presented cumulatively and not by state.

Chapter 3: American Indian and Alaska Native Village Need

American Indian and Alaska Native Village-Specific Needs

The combined American Indian and Alaska Native Village water system need estimated for the 2015 Assessment is $3.8 billion in capital improvements over the next 20 years. This need includes drinking water infrastructure to increase access to safe drinking water through compliance with EPA's drinking water regulations, as well as connection of homes without piped water to existing public water systems. Exhibit 3.1 presents the American Indian and Alaska Native Village water system need by EPA regional offices and by project category.

The American Indian and Alaska Native Village water system needs are extrapolated from the findings of the 2011 Assessment, which were based on statistically designed surveys of American Indian and Alaska Native Village water systems. These were the first surveys of these systems since 1999, and they incorporated the changes to EPA's approach and policies for estimating infrastructure needs of non-tribal systems between 1999 and 2011. Extrapolation from the 2011 findings was based on the Construction Cost Index (CCI) compiled by McGraw Hill Construction and application of current cost models.

Exhibit 3.1: 20-year Need for American Indian by EPA Region and Alaska Native Village Systems (in millions of January 2015 dollars)

EPA Region	Transmission and Distribution	Source	Treatment	Storage	Other	Total Need
Region 1	$3.6	$0.9	$1.1	$1.0	$0.2	$6.8
Region 2	$20.5	$1.8	$2.1	$3.0	$1.2	$28.6
Region 3*	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Region 4	$29.4	$6.3	$9.7	$8.3	$1.6	$55.4
Region 5	$123.6	$18.6	$28.1	$33.4	$6.7	$210.4
Region 6	$99.1	$15.0	$29.7	$32.4	$6.4	$182.6
Region 7	$21.8	$2.6	$4.0	$5.6	$1.2	$35.3
Region 8	$380.7	$27.9	$76.5	$79.8	$6.7	$571.7
Region 9†	$1,323.6	$91.4	$178.2	$186.0	$38.0	$1,817.1
Region 10‡	$129.6	$19.7	$35.8	$32.9	$6.5	$224.5
Subtotal - American Indian Systems	**$2,132.0**	**$184.3**	**$365.3**	**$382.4**	**$68.4**	**$3,132.4**
Alaska Native Village Systems	$303.8	$43.7	$190.6	$118.9	$5.5	$662.5
Total	**$2,435.8**	**$228.1**	**$555.8**	**$501.3**	**$73.9**	**$3,795.0**

Note: Numbers may not total due to rounding.

* There are no American Indian water systems in EPA Region 3.

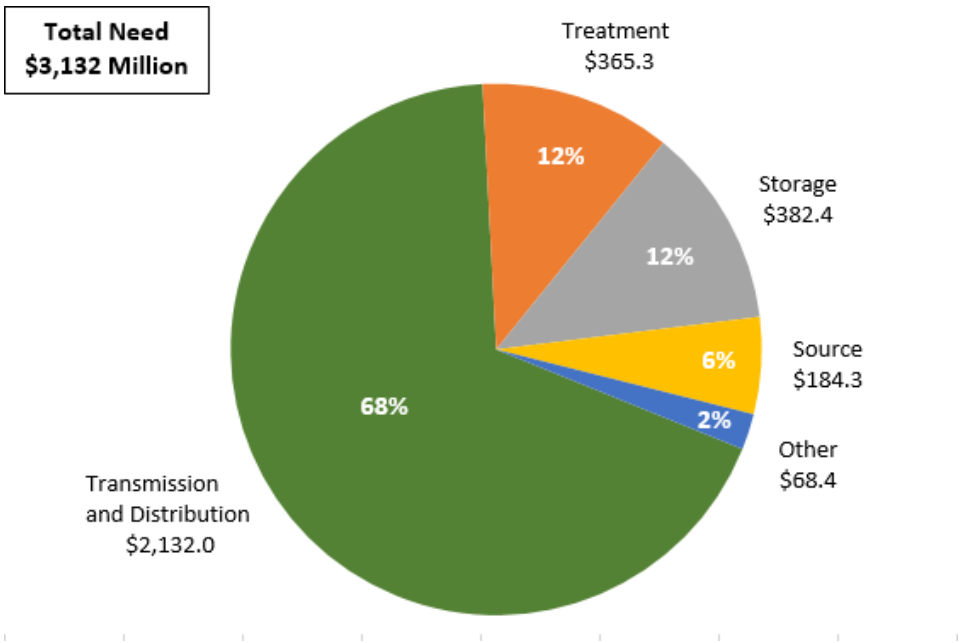
† Navajo water systems are located in EPA Regions 6, 8, and 9, but for purposes of this report, all Navajo water system needs are reported in EPA Region 9.

‡ Needs for Alaska Native Village water systems are not included in the EPA Region 10 total.

American Indian Needs

The total 20-year need for American Indian water systems is estimated to be $3.1 billion. Exhibit 3.2 shows the total American Indian water system need by project category. The American Indian need includes substantial infrastructure to increase access to safe drinking water through connection of homes without water to existing public water systems. As would be expected for these systems, transmission and distribution is the largest project category, representing 68 percent of the total need. This high percentage reflects the significant infrastructure and logistical challenges associated with American Indian water systems, which serve widely dispersed populations in remote locations.

Exhibit 3.2: Total 20-year Need by Project Category for American Indian Water Systems (in millions of January 2015 dollars)

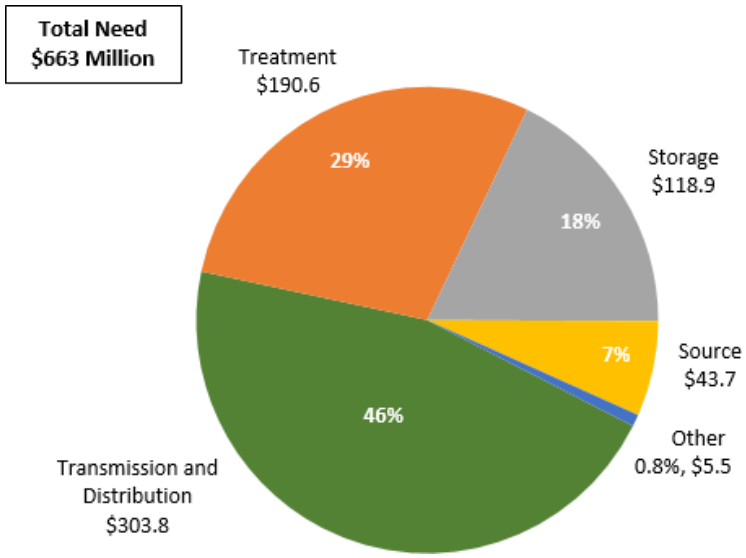


Note: Numbers may not total due to rounding.

Alaska Native Village Needs

The 2015 total 20-year need for Alaska Native Village water systems is estimated to be $0.7 billion. Exhibit 3.3 shows the total Alaska Native Village water system need by project category. The need for Alaska Native Village water systems differs from more typical CWSs in that costs for piping make up less than half the need, with storage and treatment comprising a greater percentage of the total. These smaller communities with homes in close proximity typically have lower relative costs for piping. They face higher treatment and storage costs in many locations to accommodate seasonal source water availability. Piping, treatment, and storage costs for same-size projects are higher than typical for the states because of the remote locations or arctic conditions of Alaska Native Villages.

Exhibit 3.3: Total 20-year Need by Project Category for Alaska Native Village Water Systems (in millions of January 2015 dollars)



Note: Numbers may not total due to rounding.

Pipe used for water main replacement in Houston, TX.

Chapter 4 Conclusions

EPA, along with state, tribal and local stakeholders strive to ensure each Assessment accurately reflects the true DWSRF-eligible need of small, medium, and large public water systems throughout the country, including those serving American Indian and Alaska Native communities and the U.S. territories. EPA and its partners also strive to capture emerging drinking water industry challenges and assess those impacts on the total national need. Survey response data and feedback from the DWINSA workgroup identify trends and data gaps, allowing EPA to improve and refine the design of future surveys to more fully capture and assess system needs.

The DWINSA is a significant endeavor that captures responses from more than 2,500 large and medium water systems (as well as small systems and systems in American Indian and Alaska Native Villages in previous Assessments). A response rate of nearly 100 percent from systems surveyed, as well as other information, demonstrates a current 20-year need for funding of DWSRF-eligible projects of over $470 billion. This quadrennial nation-wide survey is uniquely positioned to capture changing industry conditions in the future.

In addition to its fundamental purpose as a data collection instrument, the Assessment also strives to serve as a useful tool for utilities by promoting asset management, including the development of a record of system infrastructure assets and their condition. EPA has received feedback from partners that the approach to the survey has been successful in contributing to enhanced asset management in the drinking water sector. EPA looks forward to working with partners to build on this success to further improve estimates of overall infrastructure investment need for projects that can be funded through the DWSRF and to continue to enhance infrastructure asset management for the sector in the future.

Appendix A - Survey Methods

The 1996 Safe Drinking Water Act (SDWA) Amendments direct the U.S. Environmental Protection Agency (EPA) to assess the needs of water systems and to use the results of the quadrennial Assessment to allocate Drinking Water State Revolving Fund (DWSRF) monies. The DWSRF monies are allocated based on each state's share of the total state need with a minimum of 1 percent of the state allotment guaranteed to each state, Puerto Rico, and the District of Columbia. The results of the Assessment are also used to allocate the percentage (recently 1.5 percent) of the DWSRF appropriation designated for the U.S. territories (the U.S. Virgin Islands, Guam, American Samoa, and the Commonwealth of the Northern Mariana Islands). Further, the results of the Assessment are used, in part, to allocate the DWSRF appropriation (recently 2 percent) designated for the American Indian and Alaska Native Villages to nine EPA regional offices for grants to these water systems (EPA Region 3 does not have any federally recognized tribes). The Drinking Water Infrastructure Needs Survey and Assessment (DWINSA or Assessment) estimates the need for both community water systems (CWSs) and not-for-profit noncommunity water systems (NPNCWSs).

The 20-year period captured by the 2015 Assessment is from January 1, 2015, through December 31, 2034. The Assessment is based on 2,562 responses to a survey of large and medium water systems in states, Puerto Rico, the District of Columbia, and U.S. territories. It also included an estimate of small system needs using data from the 2007 Assessment for small water systems, and an estimate of the needs of NPNCWSs using data from the 1999 Assessment. The 2015 Assessment also included an estimate of the needs of American Indian and Alaska Native Village water systems based on data from the 2011 Assessment.

The Assessment was developed in consultation with a workgroup consisting of state and EPA regional coordinators. The workgroup met several times by conference call and in person and reached a final consensus on the Assessment's policies and processes. Except where noted, the basic statistical and survey methodologies of the 2015 Assessment are nearly identical to those used in previous Assessments. The 2015 Assessment used the same survey method for the large systems as for past Assessments; however, a slightly modified approach was used for medium systems, which is described in more detail later in this Appendix. The questionnaire used in the 2015 Assessment was essentially the same as the 2003, 2007, and 2011 questionnaires.

In compliance with the Paperwork Reduction Act (44U.S.C. 3501 et seq.), the survey design and instrument were reviewed and approved by the Office of Management and Budget (OMB). The Information Collection Request for the survey can be accessed in the Federal Register (80 FR 13538; March 16, 2015).

Assessing the Needs of Water Systems in States and U.S. Territories

Statistical Frame

The frame is the list of all members (sampling units) of a population from which a sample will be drawn for a survey. For this Assessment, the frame consisted of all medium and large CWSs in each state, Puerto Rico, the District of Columbia, and the U.S. territories. As discussed below, this Assessment used the result of the 2007 Assessment for small CWSs and excluded small systems from this survey's frame. American Indian and Alaska Native Village systems were not included in the 2015 survey; as discussed below, the results from the 2011 Assessment were used to estimate needs for these systems.

To ensure that the survey accounted for all medium and large CWSs in the nation, the universe of water systems was obtained from the federal Safe Drinking Water Information System (SDWIS-FED). SDWIS-FED is EPA's

centralized database of public water systems. It includes the inventory of all public water systems and provides information on the size of the population served by each system and each system's water source (ground water, surface water, or both).

Each state was asked to review the frame and verify or correct information on each system's source water and population served. EPA used this updated information to create a complete list of medium and large CWSs. A sample of systems was then selected from this updated frame.

Modified Panel Approach and the Stratified Sample

The inventory of systems from which the sample was drawn included 9,249 CWSs, including medium and large systems in states that fully participated and large systems in the partial participation states (see "Conducting the Survey of Medium Systems" below for more information about full and partial participation states). The inventory of 9,249 systems does not include the 597 medium systems in partial participations states, nor small systems. Because it would be prohibitively expensive to collect information from every system, EPA collects information about the infrastructure investment needs from a sample of these systems. The 2015 Assessment was designed to achieve a desired level of precision for state-level estimates of total infrastructure needs for medium-size systems serving between 3,301 and 100,000 people. EPA used a modified panel approach that includes a census of large systems and a statistical sample of medium systems to estimate total capital needs. This statistical approach minimizes burden while achieving the desired level of precision.

A panel (or longitudinal) approach tracks a cross-section of observations over time and is common in econometric studies of individuals, households, firms, and utilities. It provides advantages in terms of survey/assessment costs and reduced burden, while allowing for trend analyses and providing probability samples of systems on which estimates of each state's needs can be based. For the 2015 Assessment, rather than selecting a completely new sample of systems, EPA reassessed the needs of most of the systems that participated in the 2011 Assessment. This approach reduced the amount of time required for systems to prepare and for states to review the responses from systems resurveyed in 2015. While the panel approach reduces the burden of the survey, it does have a potential drawback. If a completely new sample were selected for each Assessment, the sampling error would be a random component that changed from survey to survey. With a panel approach, this error becomes systematic. To partially alleviate this potential source of bias, EPA modified the panel approach by replacing 25 percent of the sample of systems serving 3,301 to 100,000 people. This approach ensured that EPA could continue to meet the precision targets for each state.

To meet the state-level precision targets, EPA started with the sample of systems used in the 2011 Assessment. EPA adjusted the sample size required to accommodate changes in the inventory of systems, including the addition of new systems, the removal of systems that are no longer active, and the movement of systems among strata (groups). As in the 2011 Assessment, EPA first determined the total sample size needed for each state to meet the target level of precision. EPA then allocated the sample among strata in order to maximize the efficiency of the design.

To determine aggregated needs, water systems were divided into strata by size (population served) and by source (surface water or ground water). Exhibit A.1 shows the population and source water strata for the state survey.

Exhibit A.1: Stratification of the State Community Water System Survey

<table>
<tr><th></th><th colspan="2">Population</th><th>Surface Water</th><th>Ground Water</th></tr>
<tr><td>Large Systems</td><td colspan="2">>100,000</td><td colspan="2" rowspan="2">Sampled with certainty - All systems receive questionnaire</td></tr>
<tr><td rowspan="4">Medium Systems</td><td colspan="2">50,001-100,000</td></tr>
<tr><td>25,001-50,000</td><td rowspan="2">or 10,001-50,000*</td><td colspan="2" rowspan="3">State-specific samples for participating states</td></tr>
<tr><td>10,001-25,000</td></tr>
<tr><td colspan="2">3,301-10,000</td></tr>
</table>

* In some states, systems serving 10,001 – 50,000 can be considered one stratum and precision targets can be met. The most efficient sample is drawn for each state.

EPA designed the sample to estimate the need for each state, Puerto Rico, the District of Columbia, and the U.S. territories with a precision target of ± 10 percent with 95 percent confidence. To meet this target, all large systems (serving more than 100,000 people) were surveyed. These systems have the largest infrastructure needs and have the staff to respond efficiently to the 2015 Assessment. EPA also surveyed a stratified random sample of medium systems (serving 3,301 to 100,000 people) in each fully participating state and, because there are so few, all of the medium and large systems in the U.S. territories. This methodology further reduces burden and still achieves the Assessment data quality objectives.

The population served by each system includes a system's retail customers and any consecutive populations (people that are served by other water systems that purchase water from the system). Consecutive populations are included in the system population because critical infrastructure of the wholesale system would need to be sized to accommodate the demand of the population directly served by the consecutive system.

Systems are categorized as surface water if they have at least one source that is surface water or ground water under the direct influence of surface water (GWUDI). Systems are categorized as ground water if they do not have a surface water or GWUDI source. The ground water category includes ground water systems and systems that do not have a source of their own and purchase finished water from another system (regardless of whether the purchased water comes from a surface water or ground water source). The decision to include these consecutive systems that purchase water in the ground water systems category was based on the 1995 Assessment's findings that, in general, the needs of purchased water systems more closely resemble those of ground water systems than those of surface water systems that need to provide treatment to comply with the Surface Water Treatment Rules.

System Weights

For the large and medium systems surveyed, the 2015 Assessment assigned weights to the findings from each surveyed water system to determine total state needs. Because all large systems are included in the survey, each large system has a weight of one. The number of medium water systems selected from each stratum was determined by the total number of systems in that stratum (see Exhibit A.2), the percentage of that state's need represented by that stratum in the most recent Assessment, and the relative variance of the need within that stratum

in the most recent Assessment. The sample is allocated among the strata in a manner that lets the survey achieve the desired level of precision with the smallest sample size for each state. For medium systems, the sampled systems were selected by stratum and assigned an initial weight equal to the total number of systems in that stratum divided by the number of systems in that stratum's sample. For medium systems, a final weight was recalculated for each stratum with adjustments for non-response as discussed in more detail below.

Each fully surveyed state's need was determined by summing the cost of each project for each system, and then multiplying each system's need by the system's final weight. Relatively small changes in need in a medium system with a high weight can result in a significant impact on a state's need. The need for each project is multiplied by the system's statistical weight. The higher the weight, the higher the impact.

Final Sample

During data collection, new information provided by responding systems changes the sample such that the final sample varies from the initial. In addition, some systems do not respond to the survey request and this also changes the final sample. Exhibit A.2 shows the initial number of systems in each sampling stratum, the sample target size, non-responding systems, systems removed from the sample, migrating systems, and the final sample size. Details of the adjustments to the sample are provided below.

Exhibit A.2: Number of Systems in Frame and Sample by Source Type and Population Served

Source Type	Size Category	Population Served	Number of Systems in the Frame	Sample Required to Meet Precision Targets	Non-Response	Net Strata Migration	Systems Removed from Sample	Final Sample
Ground Water	Medium	3,301-10,000	3,622	519	1	14	11	521
		10,001-50,000*	2,490	588	1	15	7	595
		50,001-100,000	396	153	0	0	1	152
	Large	More than 100,000	269	269	0	-31	5	233
Surface Water	Medium	3,301-10,000	843	165	0	8	2	171
		10,001-50,000*	1,043	307	5	18	1	319
		50,001-100,000	298	160	1	1	0	160
	Large	More than 100,000	439	439	0	-25	3	411
Total			**9,400**	**2,600**	**8**	**0**	**30**	**2,562**

* In some states, systems serving 10,001-50,000 people are further divided into two population categories: systems serving 10,001-25,000 people and systems serving 25,001-50,000 people.

For the 2015 Assessment, eight of the 2,600 selected systems did not respond to the survey, for an overall response rate of 99.7 percent. For systems that did respond, there were instances where systems reported a different water source or a significantly different population compared to the original information, causing systems to migrate across sampling strata. In addition, based on their response to the survey, 30 systems were removed from the final sample for the following reasons:

- Nineteen systems reported that the population they serve is less than 3,301. (The sample includes only systems serving more than 3,300 people.)
- Four systems in partial participation states reported a population of less than 100,000. (The sample does not include systems serving 3,301 to 100,000 people in states that do not fully participate in the survey.)
- Six systems reported needs with another water system. As such, their needs are accounted for elsewhere. As an example, New York City is served by three CWSs but they choose to submit one combined questionnaire for the three systems.
- One system was not a CWS and should not have been included in the frame.

The final sample that was used to estimate the national need for large and medium systems was 2,562 as shown in Exhibit A.2.

Conducting the Survey of Large Systems

Systems serving more than 100,000 people, including retail and consecutive populations, were considered large systems for the 2015 Assessment. All large systems are selected for the survey because of the unique nature of systems in this size category and because they represent a large portion of the nation's need. The population cut-off was the same threshold as used in the 2007 and 2011 Assessments. In the 1995, 1999, and 2003 Assessments, the large system category was defined as systems serving populations of more than 40,000 or 50,000.

EPA provided the survey instruments to each state for each large system in the state. States worked with each system to complete the questionnaire and collect and prepare documentation for the projects listed on the questionnaire. The state coordinators reviewed the questionnaires to ensure that the systems included all their needs, the information entered on the questionnaire was correct, the projects were eligible for DWSRF funding, and the projects were adequately documented. During their reviews, states often contacted systems to obtain additional information. The states then submitted the questionnaire and all documentation to EPA for a final review.

All of the 708 large systems that received a survey for the 2015 Assessment responded to the survey. Based on the survey responses and migration of systems between strata, the final sample include 644 systems that serve more than 100,000 people. The number of large systems in the final sample for each state, Puerto Rico, the District of Columbia, and the U.S. territories is shown in Exhibit A.3.

Exhibit A.3: Estimated Number of Medium and Large Systems in the Inventory and the Final Sample by State

State or Territory	Estimated Inventory of Systems			Final Sample		
	Serving 3,301-100,000 People	Serving More than 100,000 People	Total # of Medium and Large Systems	Serving 3,301-100,000 People	Serving More than 100,000 People	Total # of Medium and Large Systems
Alabama	366	23	389	120	23	143
Alaska	0	1	1	0	1	1
Arizona	124	10	134	22	10	32
Arkansas	196	5	201	85	5	90
California	552	135	687	37	135	172
Colorado	151	15	166	35	15	50
Connecticut	50	10	60	23	10	33
Delaware	0	3	3	0	3	3
District of Columbia	0	1	1	0	1	1
Florida	304	56	360	33	56	89
Georgia	228	22	250	41	22	63
Hawaii	0	2	2	0	2	2
Idaho	0	1	1	0	1	1
Illinois	469	21	490	33	21	54
Indiana	214	9	223	65	9	74
Iowa	147	2	149	54	2	56
Kansas	109	6	115	75	6	81
Kentucky	235	6	241	83	6	89
Louisiana	252	7	259	74	7	81
Maine	35	1	36	22	1	23
Maryland	55	5	60	25	5	30
Massachusetts	249	9	258	53	9	62
Michigan	289	15	304	37	15	52
Minnesota	171	4	175	100	4	104
Mississippi	204	1	205	87	1	88
Missouri	224	7	231	87	7	94
Montana	0	1	1	0	1	1
Nebraska	0	2	2	0	2	2
Nevada	35	5	40	14	5	19
New Hampshire	0	1	1	0	1	1
New Jersey	232	16	248	39	16	55
New Mexico	0	1	1	0	1	1
New York	318	24	342	24	24	48
North Carolina	320	22	342	72	22	94
North Dakota	0	1	1	0	1	1
Ohio	314	17	331	50	17	67

State or Territory	Estimated Inventory of Systems			Final Sample		
	Serving 3,301-100,000 People	Serving More than 100,000 People	Total # of Medium and Large Systems	Serving 3,301-100,000 People	Serving More than 100,000 People	Total # of Medium and Large Systems
Oklahoma	172	5	177	63	5	68
Oregon	109	7	116	36	7	43
Pennsylvania	302	20	322	36	20	56
Puerto Rico	102	5	107	49	5	54
Rhode Island	0	2	2	0	2	2
South Carolina	159	9	168	21	9	30
South Dakota	0	2	2	0	2	2
Tennessee	253	12	265	116	12	128
Texas	1,021	65	1,086	74	65	139
Utah	106	11	117	21	11	32
Virginia	147	19	166	32	19	51
Washington	211	11	222	44	11	55
West Virginia	0	1	1	0	1	1
Wisconsin	176	7	183	32	7	39
Subtotal	**8,601**	**643**	**9,244**	**1,914**	**643**	**2557**
American Samoa	1	0	1	1	0	1
Guam	0	1	1	0	1	1
Northern Mariana Is.	1	0	1	1	0	1
Virgin Islands	2	0	2	2	0	2
Subtotal	**4**	**1**	**5**	**4**	**1**	**5**
Total	**8,605**	**644**	**9,249**	**1,918**	**644**	**2,562**

Conducting the Survey of Medium Systems

Medium systems, as defined for the 2007, 2011, and 2015 Assessments, serve 3,301 to 100,000 people. Exhibit A.3 shows the number of medium systems in the final sample by state and an estimate of the total number of medium systems in each state. (States with zeros in the medium system sample column opted not to collect data for these systems.)

For the 2015 Assessment, states that received the minimum 1 percent DWSRF allotment in the 2011 Assessment were given the option of not participating in data collection for medium systems. This option was provided to reduce the burden of the Assessment on states whose allocation is unlikely to be affected by the findings of the survey. Of the minimum allocation states, 14 chose not to participate in this portion of the survey. The medium system need for states that chose this option was estimated using data from participating states and the inventory of medium systems in the partial participation states. Use of this method allowed EPA to meet its precision target for each full participation state as well as at the national level. It does not meet precision targets for the partial participation states and therefore their needs are not reported individually by state.

For states that participated in the medium system portion of the survey, the data collection process was similar to that of large systems. Survey instruments were provided to the states for the medium systems in each state's sample. States worked with the systems to complete the questionnaire and collect and prepare documentation for the projects listed on the questionnaire.

Once the need for medium systems in the fully surveyed states was calculated, EPA used it to estimate the need for the partial participation states. An average need per system was calculated by stratum using data from the fully participating states and applied to the inventory of systems in the partial participation states. The inventory of systems was verified by state personnel.

Of the 1,892 medium systems that were randomly selected and received a survey, responses were received for 1,884 systems for a response rate of 99.6 percent. Based on the survey response and migration of systems between strata, 1,918 of the survey responses were for systems that serve 3,301 to 100,000 people. The number of medium systems in the final sample for each state, Puerto Rico, the District of Columbia, and the U.S. territories is shown in Exhibit A.3.

Assessing the Need for Small Systems

The infrastructure need reported for small systems serving 3,300 people or fewer is based on the findings of the 2007 Assessment when data were collected through a field survey of 600 small water systems. The 2007 small system sample was designed to estimate the national need of small systems with a 95 percent confidence interval of plus or minus 25 percent. Because the field survey data are believed to be highly accurate and due to resource constraints, EPA did not survey these systems again in 2015. Instead, EPA used the projects reported for the 2007 Assessment, applied the 2015 cost models, converted all costs to 2015 dollars, calculated the average need per small system, and multiplied this average by the number of small systems in the 2015 inventory to estimate the 2015 needs for these systems.

Assessing the Need of Not-for-Profit Noncommunity Water Systems

NPNCWSs are eligible for DWSRF funding. The 2015 estimate of need of NPNCWSs was based on the findings of the 1999 Assessment, which surveyed a statistical sample of these systems. These findings were adjusted to January 2015 dollars using the Construction Cost Index. The national need for NPNCWSs was allocated among the states in proportion to the 1999 inventory of NPNCWSs in each state in a manner similar to that used for small systems with an adjustment to 2015 dollars.

During the 1999 Assessment, EPA collected data from a national sample of 100 NPNCWSs through site visits. Unlike the sampling design for CWSs, the NPNCWS sample was not stratified into size and source categories because EPA lacked the empirical information on variance necessary for developing strata. The sample used for the 1999 Assessment for NPNCWSs was designed to provide a 95 percent confidence interval that is within a range of ± 30 percent of the estimated need.

Very little information about the needs of NPNCWS's was available before the 1999 Assessment, including data on the number of not-for-profit systems, the type of infrastructure needed, or their total need. The cost of collecting this information is high because there are a large number of non-community systems and site visits would be required to collect information about their projects and needs. Despite their large number, it was expected that their total need would be relatively low and would have a small impact on the estimate of the national and each state's needs. In 1999, EPA selected a small sample of NPNCWSs to minimize the cost of collecting these data. Therefore, the margin of error for NPNCWSs is larger than for CWSs. In addition to the high margin of error, the

fact that the data are more than 16 years old and that the inventory of NPNCWS's and their total need may have changed significantly since the 1999 Assessment diminishes the confidence in the need estimate. Due to the small total need for NPNCWSs, this is likely to have a small effect on the estimated need nationally and of each state.

Assessing the Need of American Indian and Alaska Native Village Water Systems

The infrastructure need reported for American Indian and Alaska Native Village systems is based on the findings of the 2011 Assessment. For the 2011 Assessment, EPA regional offices provided assistance in data collection. Because of resource constraints, EPA did not survey these systems again in 2015. Instead, EPA used the projects reported for the 2011 Assessment, applied the 2015 cost models, and converted all costs to 2015 dollars to estimate the 2015 needs for these systems.

Appendix B - Data Collection

To determine the scope of water systems' 20-year need, data are collected on capital improvement projects. States and other agencies work with the surveyed systems to identify applicable projects. To be included in the U.S. Environmental Protection Agency (EPA)'s Assessments, each project had to meet each of the following four criteria:

- The project must be for capital improvement.
- The project must be eligible for Drinking Water State Revolving Fund (DWSRF) funding.
- The project must be in furtherance of the public health protection goals of the Safe Drinking Water Act (SDWA).
- The project must be submitted with supporting information that documents that the three other criteria are met.

Projects included in the Assessment generally fall into one of two categories that describe the reason for the project:

- Replacement or rehabilitation of existing infrastructure due to age or deterioration.
- New or expanded infrastructure to meet an unmet need for the current population or to comply with an existing regulatory requirement.

Projects for infrastructure generally expected to need rehabilitation or replacement in the 20-year period covered by the Assessment were accepted with minimal documentation describing their scope and the reason for the need. However, other types of projects required independently generated documentation that not only identified the need but also showed clear commitment to the project by the water system's decision-makers. Exhibit B.1 summarizes the types of projects that were included and the types that were unallowable.

Exhibit B.1: DWINSA Allowable and Unallowable Projects

DWINSA Allowable Projects	DWINSA Unallowable Projects
Criteria: • Eligible for DWSRF funding • Capital improvement needs • In furtherance of the public health goals of the SDWA • Within the Assessment time frame • Adequate documentation Project Types: • New or expanded/upgraded infrastructure to meet the needs of existing customers • Replacement or rehabilitation of existing undersized or deteriorated infrastructure	• Raw water reservoir- or dam-related needs • Projects needed primarily to serve future population growth • Projects solely for fire suppression • Projects for source water protection • Non-capital needs (including studies, operation and maintenance) • Needs not related to furthering the SDWA's public health objectives • Acquisition of existing infrastructure • Projects not the responsibility of the water system • Projects or portions of projects started prior to January 1, 2015 • Projects or portions of projects needed after December 31, 2034

For the purposes of assigning a cost to each need, the survey required that the water system either provide an existing documented cost estimate or the information necessary for EPA to assign a cost. This information was referred to as the "design parameter" and is discussed in more detail in this Appendix.

Survey Instrument

As with previous Assessments, the 2015 questionnaire was the survey instrument for reporting all needs. The states were provided the survey package, which included an electronic file questionnaire for each system in the sample, instructions for completing the questionnaire, and a list of codes used to convert the information to a database format. For systems that completed a survey in 2011 (all large systems and the medium systems in the panel), the state was provided an Excel version of the questionnaire with the data from the 2011 Assessment prepopulated to facilitate updating the needs for the 2015 Assessment. Similar documents were also used by the site visitors for recording small system needs in the 2007 Assessment, as well as for all American Indian and Alaska Native Village water systems in the 2011 Assessment.

The instructions included information on the background and purpose of the Assessment as well as how to identify projects that should be included in the questionnaire. Each state determined how the information would be passed on to the water systems. In addition to infrastructure needs, the survey also requested basic information from the water systems such as the size of the population served, the number of service connections, the production capacity, the source water type, and the system's ownership type. This information was compared to the information used for the sample frame. Discrepancies in source and population were investigated to ensure accurate information was used to draw the statistical sample.

Project Documentation

Each project listed on the questionnaire was required to have accompanying written documentation of its scope and why it was needed. Written documentation included statements by the water system or the state as well as more formal documents such as master plans, capital improvement plans, sanitary survey reports, and other

sources of project information. Whether the documentation could be written for the 2015 Assessment or had to be pre-existing depended on project type. EPA reviewed all documentation for every project to ensure that the project met the allowability criteria for the Assessment. See Appendix C for more information on the project allowability policies.

Cost Estimates and Modeling

As with previous Assessments, costs assigned to projects were obtained in one of two ways. If the system had an existing documented cost estimate that met the documentation criteria of the survey, EPA adjusted this cost to 2015 dollars and used the adjusted cost for that system's need. This is the preferred approach for assigning a cost to a project. If no cost estimate was available, the system was asked to provide information (design parameters) necessary for EPA to model the cost of the project. Cost models were built from the documented cost estimates provided by other survey respondents.

Acceptable forms of documentation for cost estimates were capital improvement plans, master plans, preliminary engineering reports, facility plans, bid tabulations, and engineer's estimates that were not developed for the 2015 Assessment. For each project with an associated cost, EPA needed the month and year of the cost estimate in order to allow an adjustment of the cost to January 2015 dollars.

Systems that had cost estimates were encouraged to submit design parameters regarding size or capacity of the needed infrastructure. For example, a storage tank is described in terms of volume in millions of gallons, treatment plants are based on capacity in millions of gallons per day, and pipe parameters are in diameter and length. Over 70 project types were used to describe projects and link design parameters to cost. EPA used this combination of the specific type of project, costs, and parameters as input to develop cost models. Prior to input to the cost models, the cost estimates were normalized for both time frame and location. Cost estimates prior to January 2015 were adjusted to January 2015 dollars using the Construction Cost Index. Regional variations in construction costs were normalized by location using the RS Means Location Factors Index. RS Means is a subsidiary of Gordian, which publishes an annual index used to calculate construction costs for a specific location. The factor multiplier is expressed as a relationship to the national average of one.

The vast majority of the over 70 different types of need could be modeled by EPA. The very few project types that could not be modeled were unique to individual systems and did not lend themselves to modeling (examples include de-stratification of a surface water source and off-stream raw water reservoirs).

Ultimately, some projects were not assigned a cost because the system did not provide a cost estimate and project information submitted on the survey did not include the necessary design parameters required for modeling.

Website and Database

EPA used a 2015 survey-specific website to provide an efficient method of tracking and monitoring questionnaire responses. The website allowed controlled viewing of survey information and provided a means to submit additional project information. State contacts and EPA had secure login access to the website. The website was a modification of the one used successfully for the 2003, 2007, and 2011 Assessments.

Once logged into the website, state users had access to all project data for the water systems in their state and EPA regional offices had access to the project data of states within their region. Website users were given "read only" or "read/write" access depending on whether information posted to the website could be changed by that entity. This created a transparent process and open communication between systems, states, and EPA, while also maintaining a secure environment.

The website also served as a means of communication between survey coordinators and EPA. As EPA reviewers completed the quality assurance reviews of each questionnaire, they uploaded the survey data to the website database along with specific indications of any changes that had been made to the projects and why the changes were implemented.

Each survey coordinator was able to view all projects for systems in their state and submit additional information for projects that had been changed or deemed unallowable through EPA's quality assurance review.

Quality Assurance

As with all earlier Assessments, the findings of the 2015 Assessment are reinforced by adherence throughout the project to the principles embodied in the EPA's information quality guidelines.[8] The most fundamental assurance of the high degree of information quality is the implementation of the Agency's Quality System. EPA implements the system through the development of a quality assurance project plan (QAPP) for each project, which details the specific procedures for quality assurance and quality control.

Because the Agency uses the results of this Assessment to allocate DWSRF capitalization grants to states, this Assessment (like those that preceded it) sought to maximize the accuracy of the state-level and American Indian and Alaska Native Village estimates of infrastructure needs. Decisions about precision levels, policies, and procedures were established by a survey coordinators workgroup that met regularly during the 2015 Assessment.

Accuracy was maximized at the national, state, system, and project levels through the following steps. First, since this was a sample survey, the workgroup established targets for precision of estimates in the sampling to shape the national sample design. These precision targets are discussed in Appendix A.

Second, EPA used quality assurance procedures from the QAPP to ensure that "eligible infrastructure" was clearly defined and that documentation standards were rigorously enforced. As noted previously, for a project to be included in the 2015 Assessment, documentation had to be submitted describing the purpose and scope of each project. The documentation was reviewed by EPA to determine whether each project met the eligibility criteria. The workgroup established the documentation requirements so that uniform criteria were applied to all questionnaires.

Of the 89,728 projects submitted to the survey, EPA accepted 93 percent. The 7 percent that were not allowed failed to meet the documentation criteria or appeared to be ineligible for DWSRF funding. Some projects were adjusted to correct a variety of measurement problems, such as overlap between two projects (raising the issue of double-counting), inconsistency of recorded data with project documentation, and the use of overly aggressive (short) infrastructure life cycles by states where system planning documents were not used or available.

Third, after the survey review process, the project data were entered into a database using dual data entry procedures to ensure correct transfer of the information. The uploaded data then went through a systematic verification process to identify any outliers, unexpected results, or missing data. This data validation step included

[8] "*Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility and Integrity of Information Disseminated by the Environmental Protection Agency.*" https://www.epa.gov/quality/guidelines-ensuring-and-maximizing-quality-objectivity-utility-and-integrity-information

queries which identify costs outliers for a given project size (high or low end); project parameter (size) outliers; and projects where the cost provided varied substantially from what the cost model would have predicted given the size of the infrastructure. Additional queries were run comparing total needs for a given state with other states and with findings from previous surveys. Again, each flagged project or system was investigated and resolved.

The data were then compared at the state and national levels to identify any outliers in the data. EPA investigated the outliers by reviewing the system's project documentation. If the documentation did not provide enough information to verify the project, EPA contacted the survey coordinator or the system for confirmation.

Because projects for the rehabilitation or replacement of water mains make up a high percentage of the total national need, a high level of scrutiny was applied to these data. The submitted inventory of total pipe in a system was reviewed using several analyses, including calculating the total amount of pipe per person and per connection and compared to national averages, to identify changes in total amount of pipe reported for a given system between the current and previous Assessments (for systems that participated in multiple surveys). Substantial changes in the total amount of pipe were investigated at a state level between the current and previous surveys. With respect to each respondent's reported pipe rehabilitation/replacement needs, queries were run to identify the projects with the highest reported costs, projects with the highest modeled costs, projects with the highest cost per foot of pipe, and projects where the cost provided varied substantially from what the cost model would have predicted. Each identified project or system was investigated and resolved, as needed. In some situations, data entry errors were found and resolved. Often the data reviewed were determined to be valid, with the variation attributable to one or more factors that can affect the length of pipe in a system and/or the cost of replacement, such as urban vs. rural location or environmental conditions.

Continuing Evolution of the DWINSA

Each Assessment's approach, policies, and guidelines have influenced the total national need and individual state needs reported for that effort. In all cases, specific project documentation requirements and data quality objectives were set by a workgroup including states and other stakeholders and organized by EPA. The 2003 Assessment represented a success in better capturing long-term needs than the 1995 and 1999 efforts. The 2007 and 2011 Assessments helped guide states toward a more consistent methodology in assessing those types of needs. The 2015 Assessment maintains the methodology improvements made in 2003, 2007, and 2011 and results show an increase in need associated with rehabilitation and replacement of existing infrastructure that may point to success in the continued effort to better capture those long-term needs.

EPA's quadrennial Assessment will continue to evolve, with each cycle providing valuable input as to how the next Assessment can be improved. Each of the past Assessments and future Assessments address continuing as well as emerging challenges for water utilities. EPA will work with the states and water utilities to improve each survey while maintaining the integrity of the Assessment.

Key Observations on the Assessment's Evolving Approach

1995 - 1999

For the first Assessment, the DWSRF was not yet in existence (1995) and for the second was in its infancy (1999). For the 1995 Assessment, a state/EPA workgroup helped plan and design the Assessment and although some states participated in data collection, many were unable to invest resources beyond encouraging system cooperation. For the 1999 Assessment, state programs were expected to participate in data collection. Also, by 1999, the federal DWSRF program had been established and project-eligibility criteria were defined that specifically excluded raw water dams and reservoirs, which had been allowed in 1995. Also at that time, the workgroup helped define Assessment policies including those for water meters, backflow-prevention devices, and service lines. The 1999 Assessment also included needs collected for NPNCWSs.

2003, 2007, and 2011

After the 1999 Assessment, EPA, in discussions with the water industry and the states, concluded that the DWINSA was not fully capturing systems' long-term needs outside of those identified in short term planning documents. This prompted a reexamination of the survey instrument and policies to encourage systems and states to think more broadly about existing infrastructure conditions and deficiencies. Considerable effort was invested to develop a more comprehensive approach that included inventorying existing assets and estimating the need for rehabilitation or replacement over the next 20 years. EPA provided flexibility to surveyed water systems and their states to forecast these longer-term needs. In the 2003 Assessment, states and systems responded with varying approaches for identifying assets and with different assumptions about the life cycles of those assets. These changes resulted in a significant increase in the total national need and an increase in most states' individual state needs. EPA's objective to better capture the true 20-year need was met, but the states and EPA agreed that a more consistent methodology between states should be pursued in future Assessments.

For the 2007 Assessment, EPA and the states came to a consensus on policies to achieve consistency in both methods for determining needs and each state's approach to capturing those needs. Building on the methods and approaches used by the states in the 2003 effort, EPA and the states agreed upon policies for documenting need for replacement and rehabilitation of existing infrastructure. In 2011, the documentation requirements were further refined, incorporating three elements: necessity, feasibility, and an indication of commitment to the project. These elements are referred to as the weight-of-evidence determination and are further described in Appendix C.

2015

In prior surveys, EPA's sampling method included a census of all large systems and a random sample of medium systems. In an effort to continue building on previous efficiencies as well as to reduce burden on water systems, states, and EPA, a modified panel approach was implemented for the statistical sampling portion of the 2015 Assessment for medium systems. The panel (or longitudinal) approach is a statistical methodology that tracks a cross-section of observations over time and has the added benefit of allowing for trend analyses across multiple survey cycles. With this approach, EPA again conducted a census of large systems and reselected 75 percent of the medium systems that participated in the 2011 Assessment. Systems that were in both Assessments were asked to update their survey responses from the 2011 Assessment. This approach allowed systems to build on the efforts of the previous Assessment. EPA then selected a random sample from among the remaining medium systems, including systems that were dropped from the 2011 sample, to refresh the sample. This allowed some systems not selected in 2011 to be selected in 2015.

Appendix C – Statutory and Regulatory Criteria and Policies

The U.S. Environmental Protection Agency (EPA) recognizes that it is critical to the credibility of the 2015 Assessment, and equity between states, that EPA work with the Drinking Water Infrastructure Needs Survey and Assessment (DWINSA or Assessment) workgroup to set clear and well-defined data collection policies, and for EPA to apply these policies consistently to all systems. The policies are aimed at ensuring that the Assessment meets its congressional intent, maintains the credibility of the findings, and establishes a level playing field. To this end, the policies developed ensure two essential criteria - that only allowable needs are included, and that all needs are adequately documented according to Assessment criteria.

Project Allowability

Because the findings of the Assessment are used to allocate Drinking Water State Revolving Fund (DWSRF) monies, only needs associated with DWSRF-eligible projects are included in the findings. Eligibility criteria for the DWSRF are established in the Safe Drinking Water Act (SDWA). SDWA Section 1452(a)(2) states that DWSRF funds may be used:

> *"…only for expenditures (not including monitoring, operation, and maintenance expenditures) of a type or category which the Administrator has determined, through guidance, will facilitate compliance with national primary drinking water regulations applicable to the system under Section 1412 or otherwise significantly further the health protection objectives of this title...."*

To be considered an allowable need, a project must be eligible for DWSRF funding, be in furtherance of the public health protection objectives of SDWA, fall within the prescribed 20-year time frame (January 1, 2015, through December 31, 2034), and be adequately documented.

Projects Must Be for a Capital Improvement Need

Projects that do not address a specific, tangible capital infrastructure need are not included. Non-capital needs include operational and maintenance costs, water rights or fee payments, studies, computer software for routine operations, and employee wages and other administrative costs.

Projects Must Be Eligible for DWSRF Funding

Projects ineligible for DWSRF funding are identified in the DWSRF regulation and include the following:

- Dams or the rehabilitation of dams.
- Water rights.
- Raw water reservoirs or rehabilitation of reservoirs (except for finished water reservoirs and reservoirs that are part of the treatment process and are on the property where the treatment facility is located).
- Projects needed primarily for fire protection.
- Projects needed primarily to serve future population growth. (Projects needed to address a deficiency affecting current users must be sized only to accommodate a reasonable amount of population growth expected to occur over the useful life of the facility.)

Projects Must Be in Furtherance of the Public Health Goals of the SDWA

Projects that are driven by objectives not based on public health protection and the goals of the SDWA are not included in the survey. These needs can include projects for improving appearances, infrastructure demolition, buildings and parking facilities not essential to providing safe drinking water, acquisition of land for an unallowable project, and infrastructure needed to extend service to homes that currently have an adequate safe drinking water supply.

Projects Must Fall Within the 20- Year Period of the Assessment

Projects for which construction began prior to January 1, 2015, and projects that are not needed until after December 31, 2034, fell outside the time frame for the Assessment and were not included.

Projects Must Be Adequately Documented

Project documentation is a critical piece of the Assessment's credibility and fairness. It is described in more detail later in this Appendix.

Other Unallowable Needs

Besides the project criteria discussed above, other limitations established by the workgroup were:

- Infrastructure needs that occur more than once during the 20-year survey period could be listed only once on the survey.
- Multiple projects meeting the same need, such as rehabilitating a tank and later replacing the same tank, could not all be included.
- Projects driven solely by a non-water-related issue such as highway relocation were not included.
- Projects to acquire existing infrastructure were not considered capital infrastructure costs.
- Most vehicles and tools were considered operation and maintenance costs.
- Projects that are not the responsibility of the public water system.

If projects associated with an unallowable need were submitted, they were excluded from the Assessment by EPA. EPA understands that these projects often represent legitimate and even critical needs that a water system must pursue to continue to provide service to its customers. However, because they do not meet the allowability criteria they are not the subject of the DWINSA.

Documentation Requirements

The 2015 Assessment essentially maintained the documentation requirements established for the 2003 Assessment and improved upon by the 2007 and 2011 Assessment efforts. In particular, EPA and the workgroup came to consensus to incorporate the same improvements used by the 2007 and 2011 Assessments to ensure a consistent approach to data collection and to the assessment of need applied by each survey coordinator.

High-quality documentation is required to justify the need for a project, defend cost estimates provided by the water system, provide a defensible assessment of national need, and ensure fair allotment of DWSRF monies. The documentation of need and cost for each project was carefully reviewed to ensure that the criteria set in the Assessment approach and established by consensus of EPA and the workgroup were met.

Types of Documentation

In an effort to ensure more consistency in each state's approach to the assessment of its water systems' needs, the workgroup defined for the 2007 Assessment, and retained for the 2011 and 2015 efforts, three types of documentation that could be provided to describe a need or provide a cost:

- **Independent Documentation.** A document or report generated through a process independent of the Assessment. Because these documents were not generated specifically for the Assessment, it is assumed that there is no intentional bias of over reporting of need.
- **Survey-generated Documentation.** A statement or document discussing the need for a project generated specifically for the Assessment by the system or the state.
- **Combination Documentation.** A combination of independent and survey-generated documentation to justify project need or cost. Independent documentation does not always directly address the reason a project is being pursued by a system and therefore may not fully establish that the project meets the survey's allowability criteria. Systems often added survey-generated documentation to independent documents to clarify the need for the project.

Documentation of Need

Documentation explains the scope of the project, explains why the project is needed, and gives an indication of the public health need that would be addressed by the project. In order for the project to be accepted, the documentation of need must:

- Provide sufficient information for EPA to review the allowability of the project.
- Provide adequate data to check the accuracy of the data entered on the questionnaire.
- Be dated and be less than four years old.

The type of documentation required varied by the specific project type. Minimum requirements were set to allow a minor level of effort by states and water systems to document straight-forward projects. Doing so made more resources available to identify and document projects for which allowability was more questionable. Projects fell into the following levels of documentation requirements:

- Projects that required independent documentation of need.
- Projects for which survey-generated documentation were permitted but to which a weight of evidence review was applied.
- Projects accepted with any forms of documentation.

The level of documentation required depended on the type of project and whether the project was for new infrastructure or for the replacement, rehabilitation, or expansion/upgrade of existing infrastructure. Any of the three forms of documentation were acceptable for projects to rehabilitate or replace infrastructure assumed to have a life-cycle of 20 years or less.

Projects likely to be driven by a need that is not DWSRF-eligible (such as to accommodate growth or meet fire suppression needs) generally require independent documentation. Most projects for the installation of new infrastructure fall into this category. For those projects, such as the construction of a new treatment system or new storage tank, EPA reviews independent documentation and applies a "weight-of-evidence" approach to determine whether the project could be included in the Assessment.

Projects for Which Independent Documentation Is Required

Generally, projects that could be considered unallowable (such as projects to meet anticipated growth) or that are for infrastructure likely to have an expected life of more than 20 years (such as a water main) require independent documentation of need. EPA and the workgroup assumed that systems pursuing needs in this category are often in the process of formal planning and therefore independent documents are likely to exist. Projects requiring independent documentation for the 2015 Assessment included the following:

- Sources – installation of new surface water intakes, off-stream raw water storage, or new aquifer storage and recovery wells.
- Treatment – installation, replacement, or expansion/upgrade of a complete treatment plant or new treatment components.
- Storage – installation of new elevated or ground-level finished water or treated water storage.
- Pipe – installation of new water mains, rehabilitation, and replacement of a substantial portion (in excess of 10 percent of the total) of the system's existing water mains.
- Pumping – installation of new pump stations.

Weight of Evidence

Documentation must include adequate system-specific and project-specific details to verify that the project meets the allowability criteria and that the project is needed. For the 2011 Assessment, three specific weight of evidence criteria had to be supported by documentation. The project had to be shown to be:

--Necessary to meet the requirements of the SDWA and for public health purposes;

--Feasible by being typical of today's water engineering standards and practices; and

--Committed to by relevant decision-makers as specified in supporting documents or by a standing history of such commitment to similar projects, as common practice by the industry, or made evident in the documentation as a standing policy by the specific water system, state, or other relevant authority.

The 2015 Assessment continued the practice used since the 2003 effort to better capture 20-year investment needs by including an asset inventory-based approach to identify long-term infrastructure replacement and rehabilitation needs (see Appendix B).

Projects for Which Survey-Generated Documentation Is Allowed, but a Weight of Evidence Review Is Applied

Needs that are subject to a weight-of-evidence review include projects that are significant in scope or that could be for unallowable need (such as anticipated growth), but are not necessarily likely to be included in a planning document. For these projects, systems are asked to provide enough information for the reviewer to ascertain whether the project is for an allowable need. These projects include the following:

- Sources – construction of new wells or springs, new well pumps or raw water pumps, and replacement or rehabilitation of any source.
- Storage – replacement of a finished water elevated or ground level storage tank or installation of a new hydro-pneumatic storage tank.
- Pipe – a significant amount of new water main appurtenances such as valves, or backflow prevention devices, or replacement of over 10 percent of the existing inventory of those items.
- Pumping – replacement of an existing pump station or installation of a new finished water pump.
- Emergency Power –new emergency power generators.

Projects for Which A ll Forms of Documentation Are Accepted

Projects for infrastructure that is generally expected to require rehabilitation or replacement within a 20-year period are accepted with minimum documentation of need. Survey-generated documentation, including a water system's inventory of existing infrastructure assets, was sufficient for these projects, which include:

- Sources – replacement or rehabilitation of well pumps, raw water pumps, and other miscellaneous source projects.
- Treatment – rehabilitation of a complete treatment plant, or rehabilitation or replacement of treatment components, or replacement of treatment monitors.
- Storage – rehabilitation of any finished water storage tank or cistern, cover of finished water storage tank, replacement of hydro pneumatic tanks.
- Pumping – replacement or rehabilitation of any pump, or rehabilitation of any pump station.
- Pipe – rehabilitation or replacement of water mains up to 10 percent of the system's existing total pipe inventory.
- Other infrastructure such as replacement of lead service lines and installation of control valves, backflow prevention, meters, controls, and replacement of emergency power.

Documentation of Cost

To estimate a 20-year national, American Indian, Alaska Native, and individual state need, every project must have an estimated cost. There were two primary methods for assigning costs to a project:

- Systems provided an independent cost estimate.
- Systems provided adequate information for EPA to estimate a cost using a cost model.

For systems that provide a cost estimate, the documentation must:

- Include the date the estimate was derived.
- Be generated through a process independent of the Assessment.
- Be no more than 10 years old (earlier than January 1, 2005).
- Not include loan origination fees, finance charges, bond issuance fees or costs, interest payments on a loan, or inflationary multipliers for future projects.

Since projects with adequately documented costs are the basis of the cost models, systems are encouraged to provide both cost and design parameters for as many projects as possible so that the data can be used to update existing cost models.

If a cost is not provided, key information on design parameters and project type is required for EPA to assign a cost to the project using a cost model. However, EPA is unable to model a few types of infrastructure projects (i.e., projects that were too unique or site-specific). In those cases, a documented cost estimate was required in order for the cost to be included in the Assessment.

Appendix D - Accuracy, Precision, and Uncertainty

Uncertainty, precision, and bias affect the accuracy of an estimate based on a statistical sample. While a sample can be designed to meet certain precision targets, other sources of uncertainty and potential biases may diminish the accuracy of estimates.

Uncertainty

There are two types of uncertainty at play in the Drinking Water Infrastructure Needs Survey and Assessment (DWINSA or Assessment). Real uncertainties are created as survey respondents predict future needs. The U.S. Environmental Protection Agency (EPA) is asking systems not only to provide their existing needs, but also to anticipate what their future needs will be. It is difficult to predict future needs. Since no one knows, for example, when a pump will fail or exactly what it will cost to fix or replace it when it does fail, there is real uncertainty about the accuracy of estimates of future investment needs.

A second source of uncertainty is the use of a probability sample to estimate need. Uncertainties are created due to the inherent limitations of statistical analyses. The use of a random sample and cost models create such stochastic (i.e., random or arising from chance) uncertainties in the survey. In assessing the impact that the sample has on the estimate, EPA distinguishes between two sources of stochastic uncertainty: precision and bias.

Precision

Precision is the degree to which additional measurements would produce the same or similar results. Two factors affect the precision of sample-based estimates. First is the inherent variability of the data. If systems' needs are similar, the margin of error will be smaller than if needs vary greatly across systems. The second factor is the size of the sample. Larger samples produce more precise estimates than smaller ones.

The use of a random sample introduces uncertainty to the estimate. A different sample would lead to a different estimate of each state's need, since there will always be some variability among different systems selected in a sample. Because the Assessment relies on a random sample, the sample should provide an unbiased estimate of the total need. The level of confidence in the estimate is reflected in the confidence interval.

EPA's goal is to be 95 percent confident that the margin of error for the survey is ± 10 percent of the total need for systems serving more than 3,300 people for each fully surveyed state and for all American Indian and Alaska Native Village public water systems, assuming that the data provided are unbiased. (The estimates for individual partial participation states do not meet these precision targets. The Assessment also has separate precision targets for systems in the state survey serving 3,300 or fewer people.)

If the systems that responded to the survey reported the cost of their investment needs for all projects, sampling error would be the only stochastic source of uncertainty. But systems do not have cost estimates for most of the projects they reported. EPA imputed the cost of these projects using cost models based on cost estimates submitted for other projects. As with sampling, there is a degree of predictable error associated with such modeling.

Bias

Sampling error is random. It is as likely to lead to an estimate that is greater than the true value as it is lower than the true value. Bias, however, is not random. An estimator is biased if its expected value is different from the true value. An estimator is upwardly biased if it consistently leads to an estimate that is greater than the true value. It is downwardly biased if it consistently leads to an estimate that is less than the true value. The Assessment has both upward and downward biases. EPA implemented policies and procedures to mitigate the impact of these biases.

Downward bias

Past Assessments and studies of these Assessments have shown that systems are likely to underestimate their needs. There is little theory or empirical evidence to suggest that systems overstate their needs. This understatement is brought on for two primary reasons. One is that the bulk of a system's infrastructure is underground in the form of transmission and distribution mains. It is difficult to assess the need for addressing these out-of-sight assets. The second is that the survey assesses systems' 20-year need. Many systems have not undertaken the long-term planning necessary to identify future infrastructure needs.

Upward bias

In part to help address the downward bias introduced by systems' underestimating their needs, EPA enlisted the help of states in the data collection effort. However, because these entities are the recipients of the capitalization grants determined by the Assessment, there is an incentive for them to overestimate their systems' needs. This situation introduces a possible upward bias in the estimate of the needs generated by systems with this type of input.

It is unlikely that this bias applies to the Assessment estimate of small system need in the state survey. The small system survey is conducted by EPA, without states' direct involvement. For this reason, there is no upward bias in this portion of the survey. In addition, because these small system surveys are conducted by trained professionals, EPA expects very little downward bias.

Twenty-two states, the U.S. territories, and the District of Columbia have needs of less than 1 percent of the national need. These states receive the minimum Drinking Water State Revolving Fund (DWSRF) allocation regardless of the need reported (1 percent for states, Puerto Rico, and the District of Columbia; 1.5 percent for U.S. territories). For this reason, there is likely no upward bias in the allocation for these states, and only the downward bias discussed above influences need in these states.

With input from states as well as a peer-review process for the 2007 Assessment, EPA implemented policies to help address both upward and downward bias. These policies included:

- Projects to rehabilitate or replace infrastructure generally considered in need of attention within a 20-year period were allowed based on system- or other entity-signed statements and project descriptions. Systems were encouraged to consider their entire inventory and document all such needs if legitimate.
- Projects to rehabilitate or replace infrastructure not necessarily considered in need of attention within a 20-year period were allowed with documentation independent of the Assessment or a system or other entity's statement if the documentation included additional project-specific information such as an assessment of age, current condition, and maintenance history.
- Projects that include the installation/construction of new infrastructure generally received a high degree of scrutiny to ensure that they met allowability criteria.

- Some infrastructure was only allowed if independent documentation was provided. This included new surface water sources, new treatment plants or components, the replacement or expansion of an existing treatment plant, new storage tanks, and widespread replacement or rehabilitation of the distribution system (defined as more than 10 percent of the existing pipe inventory).

Appendix E - Summary of Findings for State Systems Serving 10,000 and Fewer People

Community Water Systems Serving 10,000 and Fewer People

The Safe Drinking Water Act requires that states use at least 15 percent of their Drinking Water State Revolving Fund funding for financial assistance to community water systems (CWSs) serving populations of 10,000 and fewer. Of the $459.4 billion in need for all CWS in states, those serving 10,000 and fewer people represent 29 percent or approximately $132.3 billion of needs (this number includes CWSs in U.S. territories). Exhibit E.1 presents the 20-year needs for these smaller community systems by state and project category. It also compares the reported need of these systems to the state's total CWS need. All data in Exhibit E.1 exclude needs related to not-for-profit noncommunity, American Indian, and Alaska Native Village water systems.

Exhibit E.1: State Need by Project Category for CWSs Serving a Population of 10,000 and Fewer Compared to All CWSs (in millions of 2015 dollars)

State	CWSs Serving 10,000 or Fewer People						Total 20-Year Need of All CWS*	% of CWS Need Related to Systems Serving 10,000 or Fewer People*
	Transmission and Distribution	Source	Treatment	Storage	Other	Total 20-Year Need of CWS Serving 10,000 or Fewer People*		
Alabama	$1,891.6	$45.1	$145.3	$196.6	$39.0	**$2,317.6**	$11,257.0	20.6%
Arizona	$1,047.9	$114.7	$214.4	$256.8	$16.1	**$1,649.9**	$9,107.1	18.1%
Arkansas	$2,062.2	$121.5	$317.4	$333.9	$52.9	**$2,887.8**	$7,367.6	39.2%
California	$3,613.0	$539.8	$1,393.5	$1,170.8	$69.3	**$6,786.3**	$50,904.9	13.3%
Colorado	$2,060.8	$144.8	$674.8	$363.0	$38.7	**$3,282.1**	$10,187.0	32.2%
Connecticut	$571.0	$87.0	$151.7	$139.0	$22.1	**$970.8**	$3,982.9	24.4%
District of Columbia	$0.0	$0.0	$0.0	$0.0	$0.0	**$0.0**	$1,741.9	0.0%
Florida	$1,773.6	$290.6	$435.0	$367.3	$62.8	**$2,929.3**	$21,724.8	13.5%
Georgia	$2,103.2	$244.9	$414.7	$462.8	$42.6	**$3,268.1**	$12,442.7	26.3%
Illinois	$4,641.4	$339.0	$853.7	$811.5	$86.2	**$6,731.8**	$20,771.0	32.4%
Indiana	$1,676.3	$155.3	$278.0	$305.4	$30.1	**$2,445.1**	$7,297.0	33.5%
Iowa	$2,514.1	$232.0	$425.9	$377.2	$32.1	**$3,581.2**	$7,829.1	45.7%
Kansas	$2,063.1	$164.4	$363.3	$323.0	$28.4	**$2,942.2**	$5,318.2	55.3%
Kentucky	$1,342.1	$46.8	$141.3	$178.9	$16.4	**$1,725.5**	$8,230.7	21.0%
Louisiana	$2,374.6	$212.8	$466.3	$408.7	$70.8	**$3,533.2**	$7,311.7	48.3%
Maine	$456.7	$59.1	$124.7	$118.5	$12.1	**$771.1**	$1,304.7	59.1%

State	CWSs Serving 10,000 or Fewer People						Total 20-Year Need of All CWS*	% of CWS Need Related to Systems Serving 10,000 or Fewer People*
	Transmission and Distribution	Source	Treatment	Storage	Other	Total 20-Year Need of CWS Serving 10,000 or Fewer People*		
Maryland	$575.7	$85.3	$150.6	$141.6	$15.1	**$968.3**	$9,205.8	10.5%
Massachusetts	$1,061.0	$109.7	$333.7	$288.8	$58.0	**$1,851.3**	$12,202.8	15.2%
Michigan	$2,518.6	$324.9	$494.1	$447.5	$54.0	**$3,839.1**	$12,448.6	30.8%
Minnesota	$1,687.4	$225.4	$412.3	$372.0	$56.9	**$2,753.9**	$7,168.4	38.4%
Mississippi	$2,216.4	$249.9	$489.6	$438.4	$38.0	**$3,432.2**	$4,811.1	71.3%
Missouri	$2,769.3	$279.6	$573.9	$545.5	$27.8	**$4,196.2**	$8,869.3	47.3%
Nevada	$372.7	$49.3	$134.4	$114.4	$7.6	**$678.3**	$5,298.7	12.8%
New Jersey	$848.9	$84.4	$142.8	$210.7	$20.6	**$1,307.4**	$8,325.5	15.7%
New York	$3,496.6	$433.3	$994.6	$793.5	$69.2	**$5,787.1**	$22,606.3	25.6%
North Carolina	$2,491.4	$392.5	$641.0	$496.6	$85.2	**$4,106.7**	$16,254.3	25.3%
Ohio	$2,019.4	$250.8	$605.5	$454.7	$53.7	**$3,384.1**	$13,048.3	25.9%
Oklahoma	$2,577.1	$187.8	$459.3	$421.7	$46.5	**$3,692.5**	$6,830.7	54.1%
Oregon	$1,173.0	$164.4	$394.7	$343.4	$39.6	**$2,115.2**	$6,180.0	34.2%
Pennsylvania	$3,232.4	$380.2	$1,011.0	$805.2	$139.0	**$5,567.8**	$16,415.0	33.9%
Puerto Rico	$558.3	$73.2	$221.7	$147.0	$13.8	**$1,014.0**	$3,702.6	27.4%
South Carolina	$1,192.3	$93.0	$225.6	$171.9	$30.7	**$1,713.6**	$6,106.9	28.1%
Tennessee	$1,552.4	$60.0	$192.8	$185.3	$5.0	**$1,995.5**	$8,727.3	22.9%
Texas	$8,450.2	$793.0	$1,852.4	$1,905.0	$268.5	**$13,269.0**	$45,091.0	29.4%
Utah	$686.3	$109.8	$189.2	$213.1	$19.5	**$1,217.9**	$4,338.0	28.1%
Virginia	$1,603.1	$171.9	$499.3	$421.5	$64.9	**$2,760.6**	$8,019.1	34.4%
Washington	$2,549.6	$418.4	$677.9	$653.6	$73.5	**$4,373.0**	$11,582.4	37.8%
Wisconsin	$1,447.0	$213.2	$509.7	$444.5	$18.5	**$2,632.9**	$7,957.4	33.1%
Partial Participation States†	$8,431.1	$1,013.8	$2,097.0	$1,834.2	$208.0	**$13,584.1**	$26,437.4	51.4%
Subtotal	**$83,701.4**	**$8,961.4**	**$19,703.2**	**$17,663.5**	**$2,033.1**	**$132,062.5**	**$458,405.6**	**28.8%**
American Samoa	$29.6	$3.8	$10.8	$7.5	$0.5	**$52.2**	$302.5	17.3%
Guam	$0.0	$0.0	$0.0	$0.0	$0.0	**$0.0**	$270.0	0.0%
North Mariana Is.	$49.6	$7.5	$14.4	$12.5	$1.1	**$85.1**	$198.4	42.9%
Virgin Islands	$41.2	$8.4	$11.8	$9.6	$1.2	**$72.2**	$235.1	30.7%
Subtotal	**$120.4**	**$19.6**	**$37.0**	**$29.6**	**$2.8**	**$209.4**	**$1,005.9**	**20.8%**
Total	**$83,821.8**	**$8,981.0**	**$19,740.2**	**$17,693.1**	**$2,035.9**	**$132,271.9**	**$459,411.4**	**28.8%**

* Excludes NPNCWS

† The needs for states that opted out of the medium portion of the survey are presented cumulatively and not by state. The list of partial participation states is shown in Exhibit 2.4.

Glossary

Capital Improvement Plan (CIP): a document produced by a local government, utility, or water system that thoroughly outlines, for a specified period of time, all needed capital projects, the reason for each project, and the projects' costs.

Coliform bacteria: a group of bacteria whose presence in a water sample indicates the water may contain disease-causing organisms.

Community water system (CWS): a public water system that serves at least 15 connections used by year-round residents or that regularly serves at least 25 residents year-round. Examples include cities, towns, and communities such as retirement homes.

Current infrastructure needs: new facilities or projects to address deficiencies in existing facilities for which water systems would begin construction as soon as possible to avoid a threat to public health.

Engineer's report: a document produced by a professional engineer that outlines the need and cost for a specific infrastructure project.

Existing infrastructure: Infrastructure that was in place, fully installed and providing service to the water utility prior to the commencement of this survey.

Existing regulations: drinking water regulations promulgated by EPA under the authority of the Safe Drinking Water Act; existing regulations can be found at Title 40 Part 141, the Code of Federal Regulations (40 CFR 141).

Finished water: water that is considered safe to drink and suitable for delivery to customers.

Future infrastructure needs: infrastructure deficiencies that a system expects to address in the next 20 years because of predictable deterioration of facilities. Future infrastructure needs do not include current infrastructure needs. Examples are storage facility and treatment plant replacement, where the facility currently performs adequately but will reach the end of its useful life in the next 20 years. Needs solely to accommodate future growth are not included in the Assessment.

Ground water: any water obtained from a source beneath the surface of the ground, which has not been classified as ground water under the direct influence of surface water.

Growth: The expansion of a water system to accommodate or entice future additional service connections or consumers. Needs planned solely to accommodate projected future growth are not included in the Assessment. Eligible projects, however, can be designed for growth expected during the design-life of the project. For example, the Assessment would allow a treatment plant needed now and expected to treat water for 20 years. Such a plant could be designed for the population anticipated to be served at the end of the 20-year period.

Infrastructure needs: the capital costs associated with ensuring the continued protection of public health through rehabilitation or construction of facilities needed for continued provision of safe drinking water. Categories of infrastructure need include source development and rehabilitation, treatment, storage, and transmission and distribution. Operation and maintenance needs are not considered infrastructure needs and are not included in this document.

Large water system: in this document, this category comprises community water systems serving more than 100,000 people.

Medium water system: in this document, this category comprises community water systems serving from 3,301 to 100,000 people.

Microbiological contamination: the occurrence of protozoan, bacteriological, or viral contaminants in a water supply.

New infrastructure: Infrastructure that was not in place and was not providing service to the water utility prior to the commencement of this survey.

Noncommunity water system: a public water system that is not a community water system and that serves a nonresidential population of at least 25 individuals daily for at least 60 days of the year. Examples of not-for-profit noncommunity water systems include schools and churches.

Public water system: a system that provides water to the public for human consumption through pipes or other constructed conveyances, if such system has at least 15 service connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year.

Regulatory need: a capital expenditure required for compliance with Safe Drinking Water Act regulations.

Safe Drinking Water Act (SDWA): a law passed by Congress in 1974 and amended in 1986 and 1996 to ensure that public water systems provide safe drinking water to consumers (42 U.S.C.A. §300f to 300j-26).

Small water system: in this document, this category comprises community water systems serving up to 3,300 people.

Source: a project category that includes the costs associated with developing or improving sources of water for public water systems.

State: in this document, state refers to all 50 states of the United States plus Puerto Rico, the District of Columbia, American Samoa, Guam, the Commonwealth of Northern Mariana Islands, and the U.S. Virgin Islands.

Storage: a project category that addresses finished water storage for public water systems.

Supervisory Control and Data Acquisition (SCADA): an advanced control system that collects all system information and allows an operator, through user-friendly interfaces, to view all aspects of the system from one place.

Surface water: all water that is open to the atmosphere and subject to surface run-off, including streams, rivers, and lakes.

Transmission and distribution: a project category that includes installation, replacement, or rehabilitation of transmission or distribution mains and associated appurtenances that carry drinking water from the source to the treatment plant or from the treatment plant to the consumer, as well as pump stations in the distribution system.

Treatment: a project category that includes conditioning water or removing microbiological or chemical contaminants. Filtration of surface water, pH adjustment, softening, and disinfection are examples of treatment.

Ductile iron pipe for a raw water line to a new water treatment plant in Arkansas City, KS.